THE *WAR ROOM EFFECTS MODEL* (*WREM*): A PARAMETRIC MODEL FOR THE OPTIMIZATION OF ORGANIZATIONALLY SUPPORTED DECISION MAKING ACCORDING TO THE PERSONALITY OF DECISION MAKERS

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And to Beth, thank you for seeing this through to the end with me. I love you.

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LIST OF SYMBOLS AND ABBREVIATIONS

2D ..... two-dimensional

3D ..... three-dimensional

16PF ..... *16 Personality Factor Model*

AI ..... Autocratic Style I

AII ..... Autocratic Style II

AIM ..... Affect Infusion Model

Alt ..... alternate

CI ..... Consultative Style I

CII ..... Consultative Style II

CMH ..... Center of Military History

CO ..... Subordinate Conflict

CP ..... Commitment Probability

CR ..... Commitment Requirement

CT ..... Cognitive Task

EPP ..... Eysenck Personality Profiler

EPQ ..... Eysenck Personality Questionnaire

EU ..... European Union

FFM ..... Five Factor Model

FR ..... France

GI ..... Collaborative Style I

GII ..... Collaborative Style II

GC ..... Goal Congruence

GTEMBA..Georgia Tech Executive MBA Program

HEXACO...Humility, Emotionality, Extraversion, Agreeableness, Conscientiousness and Openness to Experience.

ISYE.. Industrial and Systems Engineering

JA .... Japan

K...thousand

LI ....Leader's Information

M..million

MBTI .... Myers-Briggs Type Indicator

MAR ....missing at random

MCAR ....missing completely at random

MNAR ....missing not at random

PA ....Pennsylvania

PE-fit ....Person-Environment Fit

PEN ....Psychoticism-Extraversion-Neuroticism

PJ-fit ....Person-Job Fit

PO-fit..Person-Organization Fit

PPRF ....Personality-Related Position Requirements Form

QR ....Quality Requirement

sd...standard deviation

SI ....Subordinate Information

ST ....Problem Structure

WREM..*War Room Effects Model*

“+”...more likable

“-”...less likable

SUMMARY

The *War Room Effects Model* (*WREM*) and its accompanying *system of situational control* are proposed as a concept for the optimization of organizationally supported decisions according to the personality of the decision maker. Concepts and components of the *PEN model* of personality, the *Affect Infusion Model*, the *Vroom-Yetton model, Situational Strength* and the *Yerkes-Dodson law* provided the theoretical basis for the establishment of *WREM* as a conceptual model. Two experiments supported the identification of key sources of performance variance in the context of hypothetical decision-making scenarios. The first of these strongly supported acceptance of *WREM*'s core personality and situational factors as important sources of variance. The second experiment generally confirmed the significance of *WREM*'s core factors and further indicated that the preponderance of performance variability resulted from key interactions between personality and situational factors. This directly supported the conditional validation of *WREM* as a parametric model. Response surface analysis and model optimization led to the identification of personality-aligned *optimization solutions* as a *system of situational control*. Stochastic simulation of this system indicated dramatic improvements to decision-making performance across the examined ranges of *WREM*'s personality factors. By practically and holistically accounting for personality and situational factors in an economical theory and model, *WREM* advances our basic understanding of the dynamic interaction between these factors and their cumulative effects on cognitive performance in decision making. This research concludes by proposing *WREM* as the subject of further basic and applied research and presents a draft concept for its implementation and application to industry.

CHAPTER 1. INTRODUCTION TO *WAR ROOM EFFECTS*

1.1 Introduction

Few vignettes from the annals of American military history offer the chance to analyze factors affecting decision making where the history is rich, and many random conditions were the same for the contending commanders. The contrast between Gettysburg's ranking personalities, their decision-making processes and the battle's results are useful to illustrate the key questions embodied in this research: Are individuals with different personalities differently affected by the circumstances of decision making and how might those effects be controlled to best assure the outcomes?

Late in the night of July 2nd, 1863, ominous decisions were required of the two opposing commanders that would significantly impact the wartime fortunes of their armies. These men were comparably provisioned with forces, information and time to make the necessary preparations for effective combat action. They were also comparably intelligent, experienced and supported by traditional resources and processes designed to protect the quality of such important decisions (Coddington, 1968; Shaara, 1974).

However, the histories of the men and their fateful decisions reveal notable distinctions between them: their personalities; their manner of deciding that night; and the battle's ultimate results. As driven by their personal inclinations, one opted to forego the structure, support and access to situational control provided by the tradition of the council of war,[1] while the other did not (Freeman, 1934; Dowdey, 1965; H. Longstreet, 1904; Lee, 1904; Cleaves, 1991; Gibbon, 1888; Coddington, 1968). By the following evening, their separate decisions had been implemented and the outcomes could not have been more distinct. Confederate forces under General Robert E. Lee had been soundly defeated by Union forces under General George G. Meade. After three and a half years of indecision, the Confederate's fortunes were irreparably damaged while the Union's strategy was at last confirmed (Coddington, 1968; Shaara, 1974).[2]

Too many other factors were involved in this great military clash to attribute Lee's failure or Meade's success to either personality or the use/disuse of control over their separate decision-making processes. Nonetheless, it can be deduced that Lee made a poor decision and Meade a good one. Accepting this, it can be further considered that their personalities and the conditions under which they decided may have affected the quality of their respective decisions, and thus the battle's results.

The separate control dilemmas faced by Lee and Meade are often repeated in everyday life. This is because every person is a decision maker and is subjected to a constant stream of decisions for which the same question quietly confronts them: To control or to not control, and if so, then how? It may be rare that these everyday decisions are so consequential as those required from Lee and Meade at Gettysburg. Nonetheless,

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[1] The council of war (or war council) is a traditional, collaborative decision making paradigm, typically reserved for critical wartime decisions. The council brought together senior military leadership to deliberate over a strategy, consider options, and, when possible, achieve consensus on a course of action. See Gibbon (1988) for a participant's report on General Meade's council of war at Gettysburg.

[2] The Union's victory at Gettysburg was especially meaningful due to its coincidence with the equally important Union victory over Confederate forces in Vicksburg, Mississippi, which occurred one day later. After these two major campaigns were concluded, rebel forces were in retrograde until the war ended with their surrender nearly two years later (Gallagher, 2001).

each person's decision-making performance may still depend on the conditions under which they decide and the compatibility of those conditions with their personality. And, when individual decisions are taken in an organizational context, control over the myriad factors that will affect decision making becomes less of an opportunity and more of a practical requirement. This is especially true when those decisions are directed toward achievement of critical organizational goals, like victory at Gettysburg.

While the council of war represented the principle means of formalized control for the decisions taken by Lee and Meade, many other options exist now to implement selective control over decision-making conditions. For individuals, these options may derive from education or experience and may be self-applied to control for how, when and where decision making will occur. For organizations, control options may derive from science or best-practices, and they may be selectively applied by the organization and/or the designated decision maker. However, in both cases, these controls or systems of control generally fail to account for the full breadth of critical factors affecting decision-making performance. They are particularly deficient in addressing the predictable interplay between decision-maker personality and the imposed decision-making conditions.

The literature across scientific disciplines thoroughly establishes that personality attributes and situational conditions are key factors affecting cognitive performance. By applying and testing a new conceptual model, this body of research confirms the significance of the dynamic interaction between persons and situations as *War Room Effects* and estimates their impact on performance. Based on the results, this research proposes practical, personality-aligned control options that can be systematically applied toward the optimization of decisions.

This chapter introduces the *War Room Effects Model* (*WREM*) as the basis for evaluation and selection of practical, personality-aligned controls for organizationally supported decision-making events. It also outlines the development and refinement of the research objective and hypotheses leading to *WREM,* development including literature review, field observations, two experimental studies and response surface analysis. Subsequent chapters report the details of the two experimental studies, the response surface analysis and the integration and application of the results.

What this research has established is that situational controls can be practically applied to and within the context of organizationally supported decision making to permit the exploitation of personality for improved performance. The proposed system of *WREM*-derived controls is a significant expansion on existing concepts and models for decision support, especially due to the integration of holistic personality concepts. And, while further testing and validation remain required, *WREM* uniquely highlights personality as an indispensable component in any adequate model of decision-making performance.

1.1.1 Motivation, Research Objective and Hypothesis

As a career military planner, strategist and decision maker, this researcher has been engaged over four decades in hundreds of formal decision-making events established to provide solutions for critical military problems. As reinforced by field observations and formal research, these experiences inspired a sense that the military decision makers are too-often placed in decision-making circumstances with no consideration of key individual differences that affect the quality of their judgments and delivered decisions. These key individual differences are the components of the decision-maker’s personality. And, despite personality’s active interplay with and within the decision-making processes, its implications are most-often ignored.

Within the U.S. military, considerable resources are provided to support decision making. These come in various forms including staffs, information, facilities and defined decision-making procedures. In addition, military decision makers are traditionally well-prepared for their decision-making roles by training, education and experience. However, they are also left to their own devices for the actual establishment of decision-making conditions and for the monitoring, control and post-hoc evaluation of their own performance. Thus, they bear primary responsibility to assess, select and implement any control over conditions that might increase the potential for good judgment or otherwise mitigate the risks of poor judgment. Through this research, it has been concluded that these risks are especially acute as they derive from neglect of personality-related effects.

At the start, this research was directed toward the assessment and redesign of contemporary military decision-making processes for the U.S. Army. This interest was motivated by study and practice in the military processes of planning, campaign design, strategy and operations. Intensive exposure to these processes contributed to a sense that they were ill-suited to many decision makers and that some new and adaptive process might lead to wider acceptance and better performance.[3] An initial research aim was thus adopted to evaluate decision-maker performance in the context of military decision making and to consider recommendations for refinement to the established processes.

Formal field observation supplied three important insights that dramatically

[3] The suitability of contemporary military decision-making processes is the subject of intensive scrutiny by the U.S. Army (Farris, 1995; Banner, 1997; Shoffner, 1999; Marr, 2000; Diggins, 2000; Kem, 2009a).

changed the direction of the research. First, the observations indicated that the prescribed decision-making processes only loosely described the actual processes as they played themselves out. Secondly, the frequent departures from the prescribed processes indicated no relationships with improved or diminished decision-making performance. Finally, the observations revealed that the personalities of the participants in the events were possibly the dominant forces in shaping the decision-related deliberations and the decisions produced. It was this last dynamic that became the object of further investigation.

A new research question was formed that asked whether decision makers would produce improved decisions if the supporting circumstances – including the decision-making process – were better aligned to their personal attributes and preferences. The research that followed sought to establish that decision-making performance depends upon the interaction between key situational factors and the decision-maker's personality. Once this was confirmed through experimentation, a system of situational control was developed to permit optimization of decision quality according to the decision-maker's personality.

1.1.2 The Unattended Potential of Personality in Decision Making

Like the military, many organizations are partly designed to gain and maintain advantages over their competitors by making good decisions. Evidence of this design may be observed in their human resourcing, facilities, decision-support systems and organizational documentation. Both organizations and individual decision makers within them have many options to exert control over when, where, why and how they decide. Problems may be restructured or reframed. Deliberative processes may be adapted. Environmental conditions and event timing may be adjusted. Decision-support resources may be added, subtracted or otherwise modified.

For individuals, these controls may be arbitrarily selected and self-applied according to personal preferences. They may be drawn loosely from education and experience and selectively applied by informal processes of self-, group- and process-regulation. Other controls may be imposed on them by third parties. For organizations, controls may be applied systematically or haphazardly to provide structure or procedural rigor over the respective decision-making events. These controls may include rules for who must decide, who must participate in the decision (or who must not), when to decide, how to deliberate and how to record or report the decision. However, apart from designating the ‘who’ that must decide, the other selections for control cannot be made at this time with fundamental appreciation for the implications of the decision-maker’s personality.

This situation exists because systemic logic for control over personality effects does not exist. As a result, decision makers, decision-making circumstances and the decision-making outcomes are most often accepted together by organizations as a packaged deal. Best possible outcomes may be hoped for but are otherwise unfacilitated by personality-informed control options. The absence of systemic logic for control poses risks to the quality of judgments made by and across decisions and decision makers. It is this researcher’s view that this risk could be largely mitigated or even turned to an opportunity by the implementation of a practical, personality-based system of control.

1.1.3 Research Objective and Hypothesis

The primary objective adopted for this research was to develop a practical model for the optimization of organizationally supported decision-making events according to the personality of the designated decision maker. The initial research hypothesis was established as follows: The application of practical situational controls, selected on the basis of decision-maker personality, will improve judgment and decision-making outcomes for organizationally supported decision-making events. Sequential testing of this hypothesis resulted in conditional validation of *WREM* as a parametric model. Further analysis led to delivery of a system of personality-informed situational controls for the optimization of decision-making performance.

1.2 The *War Room Effects Model*

Throughout its development and refinement, *WREM* provided focus for the selection of research objectives and experimental approaches necessary to support this entire body of research. The following sections discuss the model's applicability, its composition and the limitations of the research undertaken to deliver it.

1.2.1 WREM Description

WREM is a parametric model representing the integration of established models and theories related to persons, situations, arousal, affectivity and performance that provides new insights into variability in judgment and decision-making. The model estimates the dynamically interactive effects of personality and situational factors (i.e., *War Room Effects*) on the cognitive performance of decision makers. When applied through the accompanying system of situational control, *WREM* permits the optimization of decision quality according to a decision-maker's personality.

1.2.2 WREM Applicability

Decision-making contexts applicable to *WREM* include those where:

- A critical and complex organizational problem requires a high-quality decision.
- A single, qualified individual is established as responsible to make a decision.

- The decision-making event is established as discrete from related pre-decisional activities and implementation processes.

- The decision maker is supported in their role by tailorable resources including but not limited to formal deliberative processes, facilities and personnel.

- The physical conditions of the decision-making event are subject to control.

- The decision is authoritative and independently meaningful.

The above conditions were seen as indicative of formal, organizational decision-making processes. For those contexts where the above conditions are not met, *WREM's* applicability is possibly more limited.

1.2.3 WREM Composition

As refined through the initial research and two experimental studies, *WREM* incorporates the *Psychoticism-Extraversion-Neuroticism* (*PEN) model* of personality (H. Eysenck, 1990, 1998) with key factors, subfactors and structural concepts drawn from the *Affect Infusion Model* (Forgas, 1995, 2017), the *Yerkes-Dodson law* (Wickens & Holland, 2000 citing Yerkes & Dodson, 1908; Hanoch & Vitouch, 2004), *Situational Strength* (Meyer, Dalal & Bonaccio, 2009; Meyer, Kelly & Bowling, 2017) and the *Vroom-Yetton model* (Field & Andrews, 1998; Vroom & Yetton, 1973; Vroom & Jago, 1988).

WREM is comprised of 15 variables with *Decision Effectiveness* as the dependent variable. Six independent variables are identified as core factors and were developed at multiple levels for testing through experimentation. Three other independent variables were identified as control factors and tested at a single level. An additional five variables were included as theoretic factors, which were not developed for examination in this research. The following figure provides a depiction of *WREM*:

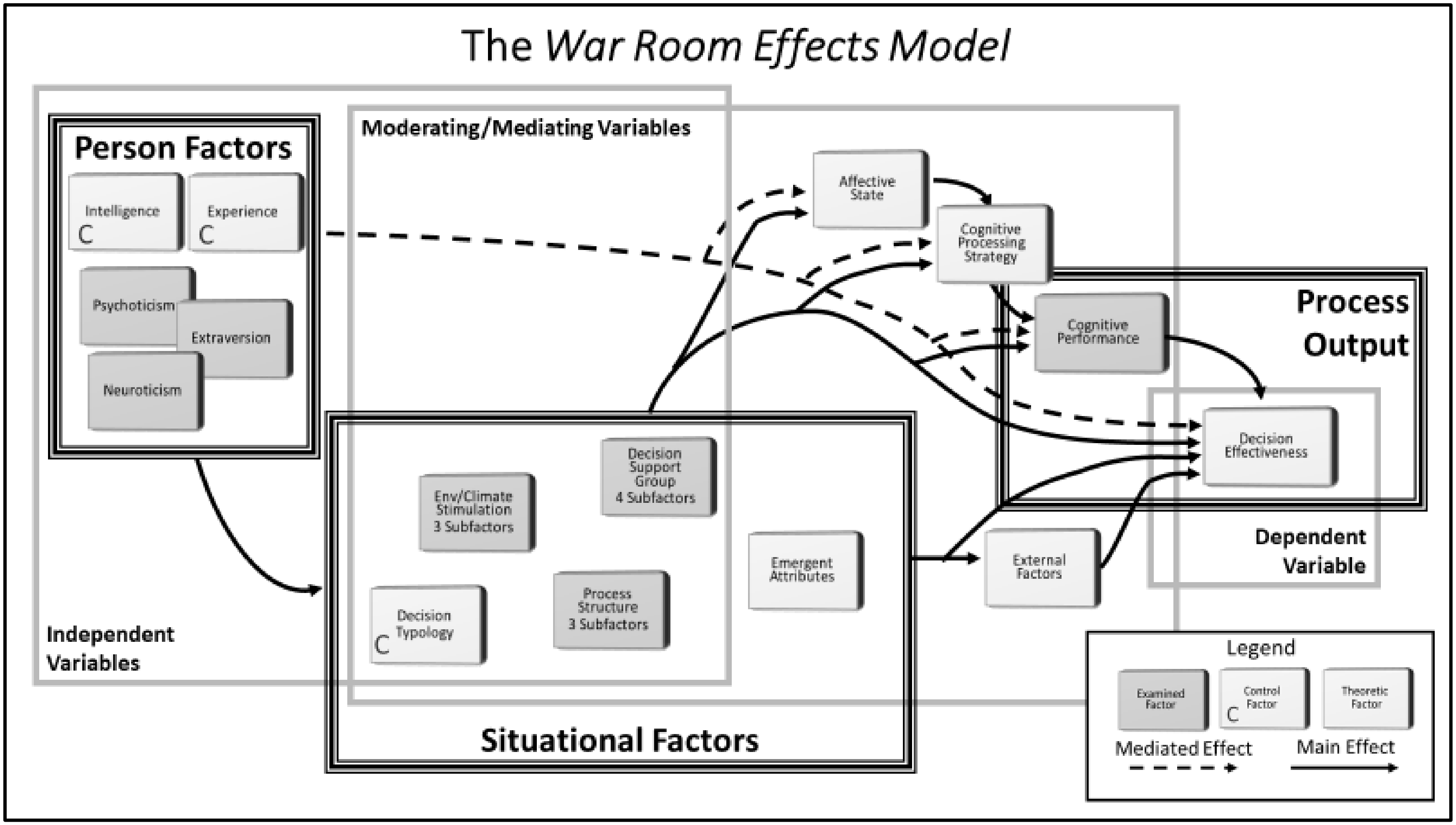

Figure 1.1 The *War Room Effects Model* (*WREM*)

Following are the definitions established for each of the *WREM* variables.

Dependent Variable:

- *Decision Effectiveness* – A theoretic, qualitative measure of success for the outcome of a fully implemented decision. This variable was not developed for use in any of the experiments related to this research due to the hypothetical nature of the decisions, which were not subject to implementation.

Independent Variables

- *Psychoticism* – The measured level of the decision-maker's tendency for aggression and for having (or not having) psychotic episodes or breaks with reality.[4]

- *Extraversion* – The measured level of the decision maker's tendency for positive affectivity and for social and external engagement. [5]

- *Neuroticism* – The measured level of the decision maker's tendency for emotionality or negative affectivity. [6]

- *Intelligence* – The measured level of a decision maker's mental abilities. This variable was developed for use as a control factor in this research.

- *Experience* – The measured level of the decision maker's task-relevant experience. This variable was also developed for use as a control factor in this research.

- *Support Group* – The measured level of interpersonal and interactive stimulation produced by a social group established to support a decision-making event. As employed in this research, this variable included as descriptive attributes: the degree to which participants are relevantly informed; the consistency of their goals; the potential for conflict among participants over a decision; and group size, familiarity and sociability.

- *Environmental Stimulation* – The measured level of sensory stimulation produced by environmental and physical sources within a decision-making event. As

[4] This is adapted from the *psychoticism* definition established at H. Eysenck (1998).
[5] This is adapted from the *extraversion* definition established at H. Eysenck (1998).
[6] This is adapted from the *neuroticism* definition established at H. Eysenck (1998).

employed in this research, this variable included visual, auditory and haptic (i.e., related to the touch or feel) stimulation as descriptive attributes.[7]

- *Process Structure* – The measured level of control imposed on a deliberative approach or method. As employed in this research, this variable included logic, rigor and clarity as descriptive attributes.

- *Decision Typology* – A categorization of decisions according to characteristics of the problem requiring a decision. As employed in this research, the component attributes of this variable included urgency, complexity, atypicality, criticality and uncertainty. This variable was developed for use as a control factor.

Other Mediating Variables:

- *Cognitive Performance* – Referred to elsewhere as *Decision Quality*, this is the qualitative measure of the suitability of a decision delivered at the culmination of a decision-making event without specific regard for its implementation. This mediating variable was selected as the dependent variable for the two experimental studies of this body of research.

- *Affective State* – A theoretic measure of a decision maker's state of mind with respect to the positivity, neutrality or negativity of affect, mood and emotions. This variable was not developed for use in any of the experiments related to this research.

- *Cognitive Processing Strategy* – A theoretic categorization of the subconsciously-selected mental processes used by the decision maker in forming their decisions. This variable was not developed for use in any of the experiments related to this research.

- *Emergent Attributes* – A theoretic categorization of dynamic factors that may arise through the processes of group deliberation and decision making. This variable was not developed for use in any of the experiments related to this research.

- *External Factors* – A theoretic categorization of dynamic factors that have potential implications for decision implementation. These factors were anticipated to arise apart from and/or following the process of deliberation and decision making. This variable was not developed for use in the experiments related to this research.

Since actual decision-making events were not planned as platforms for experimentation,

[7] Olfactory (smell) and gustatory (taste) senses were excluded as attributes based on an assumption that these senses have only random and limited roles within a typical decision-making event.

selected theoretic factors were excluded from examination due to the impracticality of validly representing them among so many factors in the experimental stimuli. Other factors were included only at control levels out of concern that a failure to represent them at all might induce unwanted variability in the experimental response. Where excluded from examination, these factors were assumed to project random effects on decision quality. Where included at control settings, it was assumed that their effects would have generally conformed to those predicted by other authoritative literature had they been examined at multiple levels. The rationale for selection of these variables and the nature of their contributions to *WREM* are reported in Section 1.4 below.

1.2.4 WREM Limitations

WREM does not directly support the selection of situational controls for decisions made by more than one individual, such as under committee or consensus-driven processes. And, while it may also facilitate the optimization of decision quality by controlling for optimal personalities given a specific set of situational conditions, *WREM* was not intended for such applications. As indicated by the conditions of its applicability, it was also not intended to model the quality of decisions formed across multiple or otherwise non-discrete events. It was understood from the start that normative decision-making may occur through discontinuous and/or recursive processes. However, estimating the implications for more diffuse or open-ended events would require greater consideration for the influence of external, emergent and random factors that have been, so far, unexamined.

1.3 Key Concept Review

WREM was conceived as the theoretic integration of concepts drawn from the literature related to personality, judgment and decision making, cognition, mood, emotions, affectivity, organizational behavior, business management and leadership. The following section describes the central concepts, related theories and their relevance to this research.

1.3.1 Personality

Among the concepts leveraged by this research, none was more important than personality. The expansive body of scholarly work on the subject provided insights into several key concepts as well as potential industrial/organizational applications. At the same time, the literature indicated enduring impediments to holistic research on personality effects in decision making. The following section provides a review and synthesis of the main personality concepts applied to this research. Other concepts and principles applied within the experimental studies are referenced appropriately in their respective chapters.

Personality's importance is broadly acknowledged across the literature related to human and social judgment, decision making, organizational behavior, leadership and business management (Landy & Conte, 2010; Zedeck, 2011). Differences in personality have been demonstrated to significantly affect many aspects of both cognition and behavior (Broadbent, 1958; Kahneman & Tversky, 1984; Parasuraman, Bahri, Deaton, Morrison & Barnes, 1992; Myers & McCaulley, 1998; Wickens & Holland, 2000, citing Scerbo, Greenwald & Sawin, 1993; H. Eysenck & M. Eysenck, 1985; McCrae & Costa, 1985a, 1997; Nairn, 2006).

Regrettably, acceptance of personality's explanatory power and its systemic application to real-world solutions are limited by disagreement over a general concept – or paradigm – for its application, and narrowly focused methods for its investigation (Ludeke, Bainbridge, Liu, Zhao, Smillie & Zettler, 2019; Dunlop & Hanley, 2019; Bandura, 1986;

Minecka, 1987; Mischel, 1968, 1973, 1996; H. Eysenck, 1991a, 1997; Fajkowska & Kreitler, 2018).

Many studies account for or employ highly specific personality factors in combination with similarly specific situational factors to estimate their effects on behavior and performance. However, these typically fail to holistically represent either personality or the situational conditions and there is often little regard for the potential interactions among the selectively included factors (H. Eysenck, 1991a; Hintz, Geiser & Shiffman, 2019; Ilkowska, 2011). Other investigations have included comprehensive or 'whole person' trait and/or type theories and models.[8] However, even these have failed to gain broad support due to perceived deficiencies in methodologies, the validity of component concepts and/or their measurement (Mischel, 1973; Myers & McCaulley, 1998; Pittenger, 1993, 2005; Boyle, 1995; Moran, 2013; Fajkowska & Kreitler, 2018).

In sum, personality is generally regarded as impactful on human performance, right alongside situational conditions and intelligence (Dalal et al., 2015; Landy & Conte, 2010; Ilkowska, 2011), but otherwise poorly integrated into human performance theories and applications (García-Gallego, Ibáñez & Georgantzis, 2017).

1.3.1.1 Personality Traits and Types

Within the field of personality psychology, certain theories emphasize the dynamic organization within individuals of psychophysiological systems that are predictive of characteristics and behaviors. Others emphasize the revealed characteristics themselves as

[8] Many employ the popular *Myers-Briggs Type Indicator* (*MBTI*) (Myers & McCaulley, 1998) or the *Five Factor Model (FFM)* (McCrae & Costa, 1985a).

the relevant predictors of behavior (H. Eysenck, 1991a; Corr & Matthews, 2009). The former viewpoint is generally represented by personality type theories, while the latter is generally represented by trait theories.

Within the trait theories, descriptions of individual dispositions, inclinations and/or habitual patterns of behavior (including cognition) are established on continuous scales of trait strength (Long, 1952; Wiggins & Trapnell, 1979; Ashton & Lee, 2007; Abel, 2019).[9] For the more-widely accepted models, component traits have been demonstrated to be relatively stable over time, especially when measured by similar means and under similar circumstances (Conley, 1985; Finn, 1986; A. Buss, 1989; Costa & McCrae, 1991a, 2002).[10]

In contrast, type theories categorize persons into discrete categories according to their measurement against factors developed from the study of the psychophysiological processes that are thought to underlie cognition and behavior.[11] The measured types are then used as the basis for predictions of behavior (Friedman & Rosenman, 1959, 1974; Jung, 1924, 1971; Briggs & Myers, 1995; Myers & McCaulley, 1998; McLeod, 2017).[12]

Trait and type theories are both subject to criticisms related to measurement, stability, generalizability and their explanations (or lack of them) for personality's relationship with its causal mechanisms or intelligence. They are also often criticized for

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[9] Cattell's (1989) 16 Personality Factors (16PF) provides a baseline set of characteristics from which most trait models draw component factors or derived hierarchies of factors.
[10] Whole Trait Theory is a recent development, which proposes to improve upon other trait personality models by establishing 'descriptive' and 'explanatory' attributes for the established traits to support a better understanding of cross-situational variability (Fleeson & Jayawickreme, 2015).
[11] Many type theories derive from Jung's eight psychological types, which categorized persons according to their preference for extraversion versus introversion, thinking versus feeling and sensing versus intuition (Jung, 1971; Briggs & Myers, 1995).
[12] The *MBTI* is among the more popular of these with 16 types based upon the combination of four factors including Jung's three bi-valent factors indicated above and a fourth factor: judging versus perceiving (Myers & McCaulley, 1998).

being either too simplistic or too complex (Mischel, 1968, 1973, 1996, 1999; H. Eysenck 1972, 1991a; Revelle, 1987; Pittenger, 1993; Boyle 1995; Funder, 1995, 2009; Block, 1995; Johnson 1997; McCrae, Terracciano, Costa & Ozer, 2006; McLeod, 2017). Despite personality's nominal importance among psychological concepts (Costa & McCrae, 1995b; Judge, Klinger, Simon & Yang, 2008), these and other concerns represent serious and persistent impediments to the study of personality as an applied science (Dunlop & Hanley, 2019; H. Eysenck, 1991a; Funder, 1995, 2009).

Extraversion is the most commonly emphasized personality factor within the trait and type models. The inherent qualities of extraversion have been demonstrated to have profound implications for behavior and cognition in the face of social stimuli. Neuroticism is also prominent among the trait theories where it has been determined to describe greater sensitivity to diverse forms of interfering stimulation or stressors (McCrae & Costa, 1985a, 1997; Goldberg, 1990; H. Eysenck, 1990, 1998; Wiggins, 1968 as cited in Gilboa & Revelle, 1994; Tellegen, 1985). Other factors, traits and types provide fodder for continued debate over their relevance and applicability.

1.3.1.2 Personality in the Workplace

Numerous studies suggest that more thorough development and integration of personality concepts would aid in identifying and controlling for sources of human performance variability in the workplace (H. Eysenck, 1991a, 1991b; Stevens & Campion, 1994; Raymark, Schmit & Guion, 1997; Dalal et al., 2015). However, a broad range of literature reveals that personality receives only superficial accounting and application to the design of work systems with the exception of personnel selection processes and team-building (e.g.: Scerbo, 2007; Durso & Alexander, 2010; Landy & Conte, 2010).

Where personality considerations are applied to the selection (or hiring) processes. they may be used to support screening for persons possessed with specific personality traits or types. Once measured, these attributes are taken as indications of the individual's suitability or unsuitability for selection, placement, retention or promotion as an estimate of the individual's *person-job* and/or *person-organization fit* (*PJ* and *PO fit*)[13] or *personality-oriented job analysis* (Landy & Conte, 2010; Judge et al., 2008; Goffin, Rothstein, Rieder, Poole, Krajewski, Powell, … & Mestdagh, 2011).

These processes screen prospective employees for key personality attributes alongside other predictors of job performance (Landy & Conte, 2010; Zedeck, 2011). Personality measurement instruments may be drawn from established tools such as 'personality item banks'[14] and applied as rationale for an organization's assessments of the 'fitness' of individuals (Landy & Conte, 2010; Raymark et al., 1997; Highhouse, Zickar, Brooks, Reeve, Sarkar-Barney & Guion, 2016; Kulik, Oldham & Hackman, 1987; Vogel & Feldman, 2009; Neuman, Wagner & Christiansen, 1999; Stewart & Carson, 1997).

The *Five Factor Model*[15] (McCrae & Costa, 1985) or similar personality models

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[13] *PJ fit* and *PO fit* are two aspects of the *Person-Environment Fit* model (Landy & Conte, 2010). Judge et al. (2008) identifies 10 personality effects on work outcomes as lucrative areas for applied personality research. On the surface, these effects reflect aspects of *PJ* and *PO fit*, which are already actively applied through industrial/organizational selection processes.

[14] Personality item banks are used to support development of personnel selection and screening measures such as Personality-Related Position Requirements Forms (PPRFs). These typically include lists of questions (or items), which may be employed in combinations on a measurement instrument to estimate personality attributes that are identified as relevant to a specific work position or organization.

[15] The *Five Factor Model* (or *FFM*) includes as 'openness to experience', 'conscientiousness', 'extraversion', 'agreeableness', and 'neuroticism' (McCrae & Costa, 1985a, 1997; Goldberg, 1990). The

may be used as the sources for these personality-based screening tools and criteria, where one level of trait strength might be taken to indicate suitability for selection, while another might indicate lesser fitness or suitability for selection (Landy & Conte, 2010; Zedeck, 2011). These processes are largely intended to support the selection and hiring of individuals with the best potential for good performance and fit. However, they do nothing to facilitate the performance of any individual after their selection.

A second industry application of personality is selection for diversity, which occurs out of recognition for the potential pitfalls of homogeneity in a work force. These processes are typically focused on generating and maintaining organizational diversity related to gender, ethnicity and culture (Neuman et al., 1999; Landy & Conte, 2010; Zedeck, 2011). Where such processes are applied to achieve personality-based diversity, the resulting selections may moderate the homogenizing effects produced by *PJ*- and *PO-fit* regimes and other attraction, selection and attrition dynamics (Landy & Conte, 2010; Schneider, 1987; Zedeck, 2011). However, selection for diversity is not aimed at facilitating individual performance, but rather, the collective performance of the crew, team or organization.

A third workplace application of personality is through support to team-building, teamwork and crew resource management. This is accomplished by employment of self-moderation techniques to prevent or lessen the negative effects of divergent attitudes and orientations on team performance. Regrettably, these techniques reflect little appreciation for the potential effects of situational factors that are likely to differently affect the performance of the individually distinct team members (Landy & Conte, 2010; Poon,

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Big Five model of personality is closely related with some minor modifications to the traits (John, 1990). These two models are often referred too interchangeably in the authoritative literature.

Koehler & Buehler, 2014). But, as with selection for diversity, these practices are designed to achieve performance improvements for teams and not for individual team members (Durso & Alexander, 2010; Freeman, 2005; Myers & McCaulley, 1998; Hirsh & Hirsh, 2007; Bakker, n.d.; Zedeck, 2011).

The imperative for applying personality in these three ways is clear: organizations do need workers to be suited to their work requirements and they do need their teams to work well together. However, the emphasis is to control for who is selected, who behaves, who decides and how they otherwise control themselves. As such, these applications fail to address how organizations might practically facilitate the individual behaviors of a wide diversity of persons who might be required to act and decide in support of organizational goals. Given the dearth of literature related to practical, personality-informed situational controls, industrial/organizational concepts, processes and systems are designed as one-size-fits-all with respect to the personality of the worker(s). The personality-based variance in their individual performance is simply accepted as a sunk cost.

1.3.2 Personality-Related Concepts

Beyond the specifics of personality, other related concepts provided key insights for the consideration and examination of interactive effects between personalities and situations. A review of literature related to mood, emotions, affect and *interactionism*[16] led to the identification of four specific concepts, which were directly applied to the development of *WREM*. These included the *Affect Infusion Model* (*AIM*) (Forgas, 1995, 2002, 2017), the *Yerkes-Dodson law* (Wickens & Holland, 2000; Hanoch & Vitouch,

[16] See Section 1.3.2.2 and footnotes 21 and 22 below.

2004), *Situational Strength* (Meyer et al., 2009; Meyer, Kelly & Bowling, 2017), and the *Vroom-Yetton model* (Vroom & Yetton, 1973). The following section discusses each of these as theories and models that supported the composition of *WREM*.

1.3.2.1 Emotions, Mood and Affect

Closely related to personality are the concepts of emotions, mood and affect. Emotions are defined as "an effect or feeling, often experienced and displayed in reaction to an event or thought and accompanied by physiological changes in various systems of the body" (Landy & Conte, 2010, p. G-6). Emotions may be mild or intense and are typically short-lived, with measurable effects on behavior and cognition. (Loewenstein, O'Donoghue & Bhatia, 2015; Forgas, 1992; Forgas., 1995 citing Ellsworth & Smith, 1988a, 1988b; Nesse, 1990; Ortony, Clore & Collins, 1988). Mood is defined as a "generalized state of feeling" (Landy & Conte, 2010, p. G-11), which is often described either as good/positive or bad/negative. Moods are typically less intense than emotions and longer lasting. Because of their longer durations, J. P. Forgas (1995, p. 41) suggests that moods may have an "insidious influence on people's cognitive processes." Because they are likely to endure across multiple cognitive processes, moods have the opportunity to mechanize errors or biases within all of them (Forgas, 1992, 1993a, 1993b, 1995, 2017; Gigerenzer, 2008; Kahneman, Slovic & Tversky, 1982; Mayer, 1986; Mayer, Gaschke, Braverman & Evans, 1992; Sedikides, 1992).

Affect is defined as "the conscious, subjective aspect of emotion" (Landy & Conte, 2010, p. G-1). Affect is also used as a generalization for mood and emotion (Forgas, 1995), which is particularly useful where the combined effects of affect, emotion and mood are the objects of interest, without regard for potentially diverse causes, intensities and durations. Affect, or affectivity, has a fundamental relationship with certain personality models such as the *Five Factor Model (FFM)* and the *PEN model* (McCrae & Costa, 1999; H. Eysenck, 1978, 1998; Widiger, 2017). In addition, it has been shown to produce significant effects on emotion/mood susceptibility, intensity and duration (Gilboa & Revelle, 1994; Larsen & Ketelaar, 1989; Davis, Kirby & Curtis, 2007). Numerous concepts identify affect-related processes as mediators of other factors' effects on cognition and behavior (e.g., Loewenstein, et al., 2015; Weiss & Cropanzano, 1995; Forgas, 1995, 2017). Included among these is the concept of *affect infusion* (Forgas, 1995, 2017). According to Forgas (1995, p. 39), this is the "process whereby affectively loaded information exerts an influence on and becomes incorporated into the judgmental process, entering into the judge's deliberations and eventually coloring the judgmental outcome."

As a model of the judgment process, *AIM* establishes that the judgments themselves depend on the affective state of the 'judge' as moderated by his or her unconsciously selected cognitive processing strategy (Forgas, 1995, 2002, 2017; Forgas & Vargas, 1998; MacAulay & Eich, 2002; Kuhne et. al, 2012; Mao, Wong; Tao Jiang, 2018; Keltner, Anderson & Gonzaga, 2002).[17] The model predicts where judgments are more or less likely to be infused, saturated or "colored" (Forgas, 1995, p. 39) by affect as a composite of mood and emotions. Depending on qualitative aspects of the decision-maker's affective state and the cognitive processing strategy, the infusion will induce judgmental bias scaled to the judge's affective strength, with the bias's positivity or negativity determined by the

[17] *AIM* is not immune to criticism as can be found in the extensive *Commentaries* section of *Psychological Inquiry*, Volume 13 (2002) including submissions by Clark (2002), Isen (2002), and Schwarz (2002).

complexity of the cognitive processing. The following figure depicts *AIM*.

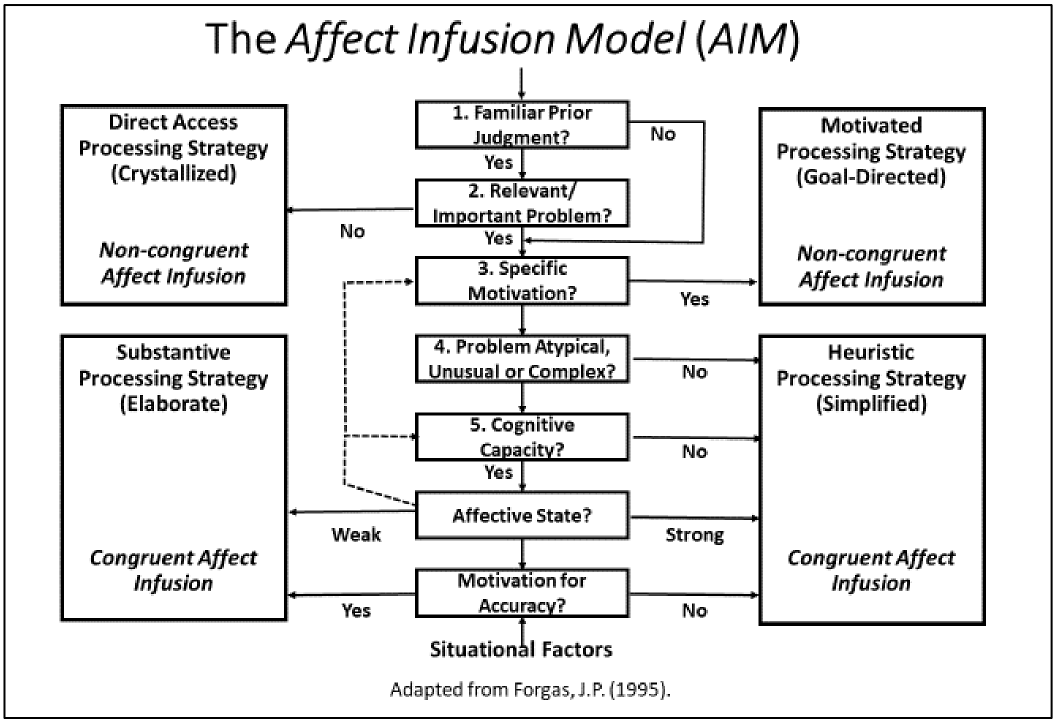

Figure 1.2: The *Affect Infusion Model* (*AIM*)

For complex processing strategies, biases are predicted to be consistent or congruent with the underlying moods and emotions (i.e., negative moods induce negative biases). On the other hand, simpler cognitive processing strategies are predicted to induce non-congruent biases (i.e., negative moods induce positive biases) (Forgas, 1995).

Given these assertions, it is interesting that Forgas (1995, 2017) makes no claim that affectively infused judgments have any correlation with judgment quality – strength or weakness – except to establish that they are distinct from otherwise un-infused, unbiased judgments. However, by establishing affect's direct and indirect effects on cognitive processing strategy selection, *AIM* clearly implicates decision quality at any point where unsuitable processing strategies may be selected that would expose the judgment to the selected strategy's inherent potential for judgmental error and bias (Payne, Bettman & Johnson, 1988; Gigerenzer, 2008; Tversky & Kahneman 1974; Sunstein, 2005).[18] And thus, while the cognitive biases explicitly predicted by *AIM* are potentially impactful on judgment quality, the broader literature indicates that the cognitive performance decrements of affectivity may derive from more than just the affective biases themselves.[19]

If affectivity were to be considered as a form, source or symptom of arousal, then *AIM* also provides a possible example of the effects predicted by the *Yerkes-Dodson law.*[20]

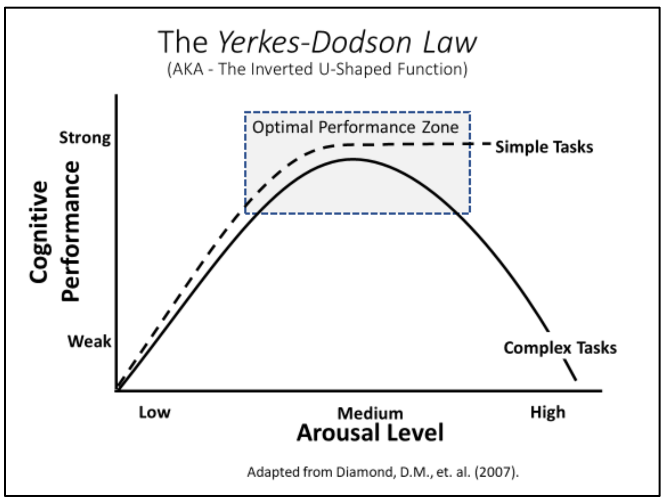

Figure 1.3: The *Yerkes-Dodson Law*

[18] The potential for selection of an unsuitable cognitive processing strategy is illustrated at step 6 in Figure 1.2 above by the 'affective state's' recursive interaction with 'motivation' and 'intelligence'.

[19] As examples of the negative implications of affect, it may prevent the allocation of the attentional resources required to support cognition and/or prevent the formation of key problem-related percepts through attentional narrowing (Wickens & Holland, 2000 citing Stokes & Kite, 1994). Affect may also cause "disordered thinking" (Davis, 1998, p. 28) or the selection of heuristics as simplified cognitive processing strategies (Gigerenzer, 2008; Gigerenzer & Goldstein, 1996). Finally, affect may limit the motivation of individuals to persevere through effortful cognitive processing or follow-through on judgments after they have been made (Pfister & Bohm, 2008; Loewenstein & Lerner, 2003).

[20] Also known as the '*inverted u-shaped function'*, this law has many critics., Since its development, it has been applied more broadly than its authors may have intended. However, it has been externally validated and it has indelibly impacted on the study of arousal and performance (Ludvigh & Happ, 1974; Anderson, Revelle & Lynch, 1989; Matthews & Gilliland, 1999; H. Eysenck & S. Eysenck, 1985; Staal, 2004; Hanoch & Vitouch, 2004; Chaby, Sheriff, Hirrlinger & Braithwaite, 2015). The ubiquity of citations to this law is somewhat contentious (see for example Scerbo (2007) and Corbett (2014)).

As illustrated in Figure 1.3**Figure 1.3** above, this law proposes that particular levels of arousal are required for strong cognitive performance, with low arousal negatively affecting both simple and complex cognitive tasks, and high arousal negatively affecting complex tasks (Staal, 2004; Anderson, Revelle & Lynch, 1989; Brookhuis & de Waard, 1993; Wickens & Holland, 2000; Hanoch & Vitouch, 2004; Chaby et al., 2015). In essence, affectivity-as-arousal could be expected to induce both affectively infused biases as predicted by *AIM* and weaker performance as predicted by *Yerkes-Dodson*.

1.3.2.2 *Interactionism* and *Situational Strength*

In the 1970s, the concept of *interactionism*[21] reestablished a fragile agreement within and across the sub-disciplines of psychology about the meaningful interplay between personality, situations and their effects on behavior (Ekehammar, 1974; Endler & Magnusson, 1976; Trevino, 1986; Endler & Parker, 1992; Reynolds, Turner, Branscombe, Mavor, Bizumic & Subasic, 2010). Its formalization as a concept came about partly in response to the temporary rise of *situationism*, which purported that situational factors were themselves sufficient to explain variations in human behavior within and across situations (Mischel, 1968, 1969).[22]

A 1975 meta-analysis established that the main effects of situational variables are often found to produce between 10 and 20 percent of behavioral variance. However, this

[21] *Interactionism* conceptualizes behavior as a function of dynamic interactions between intentionally and affectively engaged individuals with psychologically meaningful aspects of situations (Endler & Magnusson, 1976; Brooks, Buhrmester & Swann, 2010).
[22] According to later writings by Mischel, the concept of *situationism* went too far toward the negation of personality effects on behavior. He characterized the debate over the relative importance of persons versus situations as a pseudo-controversy (Mischel, 1973, p. 255) and argued that consideration for both was required in the study of behavior (Mischel, 1973, 1996).

same report also established that the main effects of personality differences produced significant variance in the behavioral responses, although these effects were less pronounced or consistent than the situational factor effects (Sarason, Smith & Dienre, 1975).[23] A surge in this sort of work promptly discredited the *situationists*' perspective (Reynolds et al., 2010). It thus became accepted that situational factors represent the dominant factors in predicting behavior under some conditions, while personality factors have increased dominance under other conditions and over time (M. Eysenck & H. Eysenck, 1980; A. Buss, 1989; Mischel, 1996; Funder, 2009).

As an outgrowth of *interactionism*, the concept of *Situational Strength* further illuminated the psychodynamic relationship between environmental, social and personality factors and their effects on behavior and cognition (Mischel 1973, 1999; Weiss & Adler, 1984; Cooper & Withey, 2009; Meyer et al., 2009; Meyer, Kelly & Bowling, 2017).[24] This theory establishes that personality effects on performance are reduced when 'clarity', 'consistency', 'constraints' and 'consequences' are relatively strong, and the personality effects are increased when these same factors are weak (Cooper & Withey, 2009; Meyer et al., 2009; Meyer, Kelly & Bowling, 2017).[25]

As an analog to *AIM*, *Situational Strength* establishes conditions under which personality is more-or-less infused into behavior. Also similar to *AIM*, *Situational Strength* makes no inference about whether the personality-infused effects have any correlation with

[23] See Table 5 in Sarason, Smith & Dienre (1975).
[24] According to Meyer et al. (2010, p. 122), *Situational Strength* is defined as *implicit or explicit cues provided by external entities regarding the desirability of potential behaviors.*" These cues are theorized to impose influences on exposed individuals that result in the moderation of behavioral variance by increasing or decreasing individual conformation to particular courses of action or behaviors.
[25] *Situational Strength*'s component factors are defined as clarity, consistency, constraints, and consequences (Meyer et al., 2009; Meyer, Kelly & Bowling, 2017).

better or worse performance. And, because *Situational Strength's* four factors cannot be readily interpreted as forms of stimulation toward arousal, their consideration in light of *Yerkes-Dodson* provides little basis for inference of performance strength or weakness apart from their correlations with established personality effects.

A possible shortcoming to the current research on both *affect infusion* and *Situational Strength* is that their theories seem to suggest a Hobsons' choice with respect to the infused effects: either negate them in aggregate, or don't. Neither concept nor the related models propose any method for the concurrent reinforcement of desirable effects with the suppression of undesirable effects. This despite that it cannot be accepted that either affective or personality effects on performance are all good or all bad.

1.3.3 The Vroom-Yetton Model

While silent on both personality effects and cognition, the *Vroom-Yetton model*[26] describes key aspects of the judgment target, the decision-maker and other associated persons (i.e., subordinates). By use of the model, control prescriptions – or styles – are indicated or contra-indicated by sequential evaluation of eight factors presented as questions. After a decision maker sequentially implements the model's rules by answering the eight questions, one of five styles is prescribed, which dictates the nature and extent of subordinate participation in the decision-making process.[27] These styles span from

[26] This is one several versions of the model proposed and validated by Vroom, Yetton and Jago, which focus on maximizing decision making performance by controlling for social participation in the decision-making event (Vroom & Yetton, 1973; Vroom & Jago, 1978, 1988, 2007). The model has two primary applications. The first is as an analytic tool used to evaluate the effects of rule adherence and style selection on performance. The second application is as a practical guide for style selection (Field & Andrews, 1998).
[27] The model represents situations where more than one style is indicated within a 'feasible set' for use in deciding. These situations require decision makers to choose a style from within the indicated set based on their consideration of other relevant factors (Vroom & Jago, 1978).

autocratic to democratic, with each designed to maximize the technical quality of the decision and its potential for acceptance and effective implementation by subordinates (Vroom & Yetton, 1973; Vroom & Jago, 1978, 1988, 2007; Field & Andrews, 1998; Cheong, Yammarino, Dionne, Spain & Tsai, 2019).

The following figure illustrates this model as a systematic method for control of decision quality.

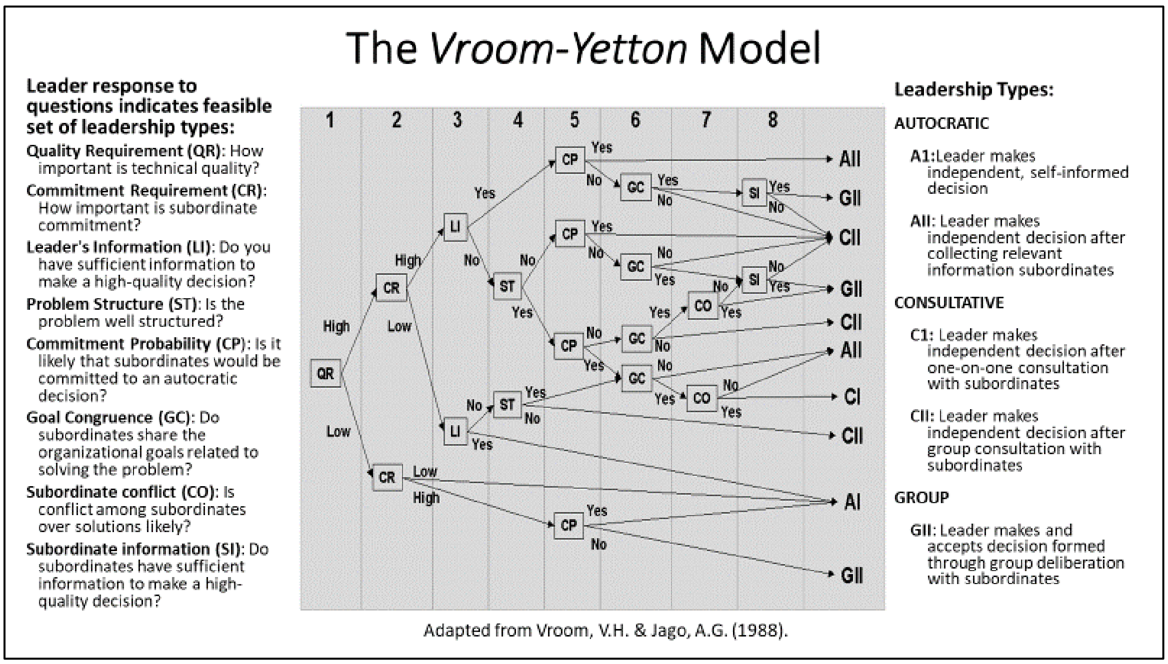

Figure 1.4: The *Vroom-Yetton Model*

With respect to individual and situational attributes of a decision-making process, the *Vroom-Yetton model*'s scope is less attuned than the other previously described concepts. For example, the model's representations of situational attributes are limited to the classification of the target problem and the prescribed decision-making style. With respect to individual attributes of participants, the model fails to account for any except by including as factors the decision-maker's subjective assessment of participants' (including self) required knowledge; the subordinate's collective regard for organizational goals; and the probability of subordinates' constructive support for the deliberative process and the implementation of a decision (Vroom & Yetton, 1973; Vroom & Jago, 1988).

However, in other respects, the model is broader than *AIM*, *Yerkes-Dodson* or *Situational Strength,* which can be observed in three aspects: it accounts for pre-decisional, control-motivated activities by the decision-maker (i.e., selection of a style); it accounts for group-induced effects (i.e. the emergence of conflict over solutions); and, it accounts for implementation effects (i.e. subordinate commitment to implementation). This expanded conception of a decision is particularly useful for the consideration of a model where both pre- and post-decisional conditions and more than one person's cognition and behavior may concurrently affect the outcome.

1.3.4 Key Concepts Summary

Despite that the literature from across several disciplines demonstrates the need for an expansive and nuanced approach to the evaluation of decision-making performance, there is no accepted theory or model that holistically incorporates problems, situations and personality, and supports their use in predicting behavior. On one hand, there is apparent confidence in the application of organizational selection processes to control for personality attributes that are estimated to negatively affect performance. On the other hand, there is separate confidence placed on the perceived effectiveness of decision-support processes and systems designed with preferred personalities and specific problem-types in mind. However, this pattern of piece-meal treatment for a decision's precursors prevents due consideration for the critical interdependencies that may be revealed when problems, persons and situations are analyzed together.

WREM provides an alternative to the selectively isolated and/or segregated treatment of person and situation factors affecting decision-making performance. By integrating key aspects of *AIM*, the *Vroom-Yetton model, Situational Strength*, the *Yerkes-Dodson law* and the *PEN model*, it was assessed that *WREM*'s testing would confirm a hypothesis that organizational decision-making events can be optimized by use of personality-aligned situational controls.

1.4 Conceptual Model Integration

The concepts discussed in the previous section provided the theoretic basis for development of a conceptual model of decision-making performance with balanced representation of persons and situations. Using the *Vroom-Yetton model* as a backdrop, it was accepted that the estimation of the key effects and interactions on decision-making performance must involve multiple stages of factor moderation/mediation (Vroom & Yetton, 1973; Vroom & Jago, 1988). This notion was reinforced by Loewenstein and Lerner's (2003) four-stage continuum of decision making, and by the progressive/recursive structure of *AIM.*

The establishment of a decision-making event was conceived as the start point for the system of processes, with decision implementation as the concluding process. *Situational Strength* provided a concept for the intersection of a decision-maker's personality and the situational conditions established to support deliberation. *AIM* was also indicated to coincide with the terminus of this person-situation intersection where *Affective State* directly impacts the decision-maker's unconscious selection of a cognitive processing strategy.[28] *The Vroom-Yetton model* also suggested the need to establish explicit representation of phenomena that may arise from group interaction and deliberation. And, finally, the *Yerkes-Dodson law* provided the basis for inference of relationships between cognitive performance and other variables that represent possible sources of arousal.

The integration and adaptation of these concepts led to the development of a framework for *WREM* and a basis for the selection and integration of its component variables. The following sections address the rationale applied to variable selection.

1.4.1 Dependent and Mediating Variable Selection

The selection of a dependent variable for *WREM* presented a challenge given the distinctions between the models and concepts discussed in the preceding section. As represented by the *Vroom-Yetton model*, the dependent variable is established as 'decision effectiveness', which is a measure of post-implementation outcomes (Vroom & Yetton, 1973; Vroom & Jago, 1988, 2007). *AIM* and *Situational Strength* establish the dependent variable as the degree to which behaviors are infused by either affect for *AIM*, or personality effects for *Situational Strength* (Forgas, 1995, 2017; Meyer & Dalal, 2009; Meyer et al., 2009; Meyer, Kelly & Bowling, 2017). And finally, 'cognitive performance' is the dependent variable for *Yerkes-Dodson (*Wickens & Holland, 2000; Hanoch & Vitouch, 2004). *Decision Effectiveness* was accepted as the dependent variable for *WREM* in acknowledgement of the effects arising from a support group's contribution to a

[28] It remains unclear whether *AIM* and *Situational Strength* would be better considered to operate in series or parallel, or whether the two could be effectively integrated in an expanded infusion model. *WREM* hypothesizes a series approach with *Situational Strength*'s four factors distributed as subfactors within *WREM*'s situational factors, all of which are proposed to mediate the relationship between personality factors and *Affective State*.

decision's technical quality and the subordinates' commitment to the decision's implementation (Vroom & Jago, 1988; Vroom & Yetton, 1973).

Of the remaining candidate dependent variables, *Cognitive Performance* was selected as a mediating variable and as an experimental proxy for the dependent variable. This selection was based upon this researcher's specific interest in the decision maker's cognitive contribution to decision effectiveness, without specific regard for decision-maker affect, behavior, or implementation. The dependent variables from *AIM* and *Situational Strength* were both excluded from the model given that these both suggest themselves to be sufficiently accounted for by either *Cognitive Performance* or *Decision Effectiveness* and the likely products of the same independent variables.

However, *AIM's* 'affective state' and 'cognitive processing strategy' variables (Forgas, 1995, 2017) were selected for inclusion as mediating variables in light of their possible implications for *Cognitive Performance* as discussed above in Section 1.4.1.[29] *Emergent Attributes* and *External Factors* were also developed for inclusion as mediating variables. This decision was based on the realization that excluded factors and phenomena related to *AIM, Vroom-Yetton, Situational Strength* or other unknown models might bear significantly on the dependent variable if and when they were identified.

[29] Further consideration of the selected *Person Factors* suggested possible difficulties related to the placement of *Affective State* and *Cognitive Processing Strategy* as mediators of the decision-making process. Clearly, these phenomena both exist in some dynamic form from the earliest stages of a decision-making process until its conclusion. However, it was determined that the repetitive representation and evaluation of these two variables and their effects would be impractical, at least until the model was more thoroughly refined. It was thus decided to align these variables in *WREM* as mediators for personality and situational effects on *Cognitive Performance*. Prior to that point in *WREM*'s system of processes, personality and *Intelligence* variables were accepted as carrier variables for them both.

1.4.2 Independent Variable Selection

As illustrated in Figure 1.1 above, independent variables include both *Situational Factors* and *Person Factors*, with the latter including personality, intelligence and experience attributes of the decision maker. The following sections address the rationale for selection of each of the variables comprising these two sets of *WREM* factors.

1.4.2.1 Personality Variable Selection

The selection of personality variables required the evaluation and selection of a single personality model. After review of literature related to personality and personality effects on cognition, it was concluded that personality trait theories lent themselves best to the analysis of cause-and-effect relationships between dimensional personality characteristics (or traits), dimensional situational characteristics and a dimensional response variable. Among those trait models considered were the *PEN model*[30] (H. Eysenck, 1998; Larstone, Jang, Livesley, Vernon & Maas., 2002; Boyle, Stankov, Martin, Petrides, Eysenck & Ortet, 2017), the *FFM*[31] (McCrae & Costa, 1985a; John, 1990; Goldberg, 1990; Wiggins & Trapnell, 1997; McCrae & John, 1992; Widiger, 2017) and Cattell's *16 Personality Factors* (*16PF*) (Cattell, 1989).

The *16PF* played an important historical role in the establishment of a "personality system" (H. Eysenck, 1991a, p. 777) by establishing a comprehensive palette of granular

[30] The *PEN model* establishes three super-factors (*psychoticism*, *extraversion* and *neuroticism*) as biologically based dimensions of personality (H. Eysenck, 1990, 1998). When measured by self-report instruments, it includes a fourth factor, called the *L-scale* and/or *social desirability* as a measure of subject dissimulation. The *L-scale*'s primary purpose is to normalize subject self-reported measures for the three super-factors (H. Eysenck & S. Eysenck, 1975; H. Eysenck & Wilson, 1991; Jackson & Francis, 1999).
[31] The *Big Five* (John, 1990) and *HEXACO* (Ashton & Lee, 2007) personality models were evaluated alongside the *FFM* and found to be similarly composed (John, Naumann & Soto, 2008).

traits. However, longstanding concerns related to replication failures for some traits, and the complexity of the model's hierarchy provided sufficient rationale for *16PF's* rejection in favor of either *PEN* or *FFM* (H. Eysenck 1972, 1991a, 1991b, 1992; Boyle, 1989).

Conceptually, *FFM* would have sufficed as the source of personality factors for *WREM*. It has been widely examined and liberally applied across the disciplines of psychology (Saucier & Goldberg, 1998; John, 1990; John, Naumann & Soto, 2008; H. Eysenck, 1991a; Widiger, 2017).[32] However, two of *FFM*'s factors (*extraversion* and *neuroticism*) are comparably described and highly correlated with the same-named factors of the *PEN model* (H. Eysenck, 1991a, 1998). In addition, Eysenck presented a convincing case for consideration of the *FFM*'s three other factors (*openness to experience*, *agreeableness* and *conscientiousness*) as components of the *PEN model*'s '*psychoticism'* super-factor (H. Eysenck, 1991a, 1998).[33] These considerations provided rationale for *FFM*'s rejection in favor of the *PEN model*. However, given the extensive work undertaken to correlate factors between *PEN* and the *FFM*, this decision was considered to be reversible (H. Eysenck, 1978, 1998; H. Eysenck & M. Eysenck, 1985; Browne & Howarth, 1977; Royce & Powell, 1983; McCrae & Costa, 1985a; John, et al., 2008).

The three super-factors illustrated in the figure below were accepted as *WREM's* personality components.

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[32] Table 1 in Digman (1990) provides a useful tabulation of the principal variants of the *FFM*, including Eysenck's *PEN model* and three other models having five or less factors.

[33] John et al. (2008) provided a rebuttal of H. Eysenck's (1991a, 1992) criticisms of *FFM* and provided an explanation for the increasing prominence of the *FFM* and related personality models as compared to Eysenck's *PEN model*.

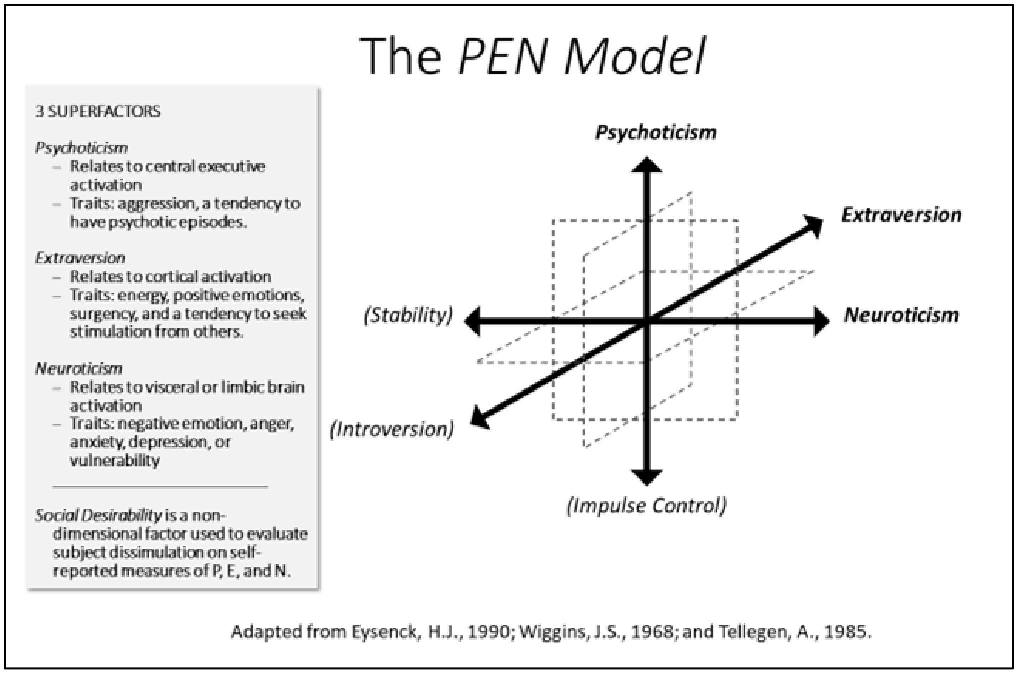

Figure 1.5: The *PEN Model* of Personality

In addition to streamlining the mathematical models required for analysis, the three-factor *PEN model* was expected to allow for development of a more practical set of personality-informed situational controls. Beyond this, the *PEN model's* linkages to biological mechanisms and neural activation indicated its possible relevance to other concepts embodied in *AIM* and the *Yerkes-Dodson law* (H. Eysenck, 1979; H. Eysenck & M. Eysenck, 1985; Strelau & H. Eysenck, 1987).[34]

1.4.2.2 Other *Person Factors*

Intelligence and *Experience* were selected for inclusion as independent variables out of recognition of their broadly established implications for human performance (Landy & Conte, 2010; Behling, 1998; Osman, 2008; Ilkowska, 2011: Englich & Soder, 2009).

[34] According to Eysenck, the principle sources of variation in human personality arise from the individually distinct levels of activation and inhibition across multiple neural systems (H. Eysenck, 1990).

These variables were seen as necessary to explain for otherwise confounding performance variance that would inevitably result from these differences among the decision makers. As the measured level of a decision maker's mental abilities, *Intelligence* was seen to implicate *Cognitive Performance*, as well as *AIM*'s 'cognitive capacity' component.[35] Similarly, *Experience* was seen to have a possible relationship with *Situational Strength*'s 'clarity' component given its established association with learning and skill acquisition (Meyer & Dalal, 2009; Meyer, Kelly & Bowling, 2017; Landy and Conte, 2010).

For purposes of experimentation, *Intelligence* and *Experience* were developed as control factors at a single level for each. This restricted use was justified by the notion that the performance of decision makers possessed with low intelligence and/or low experience was not specifically relevant to the research objective. *Conscientiousness*[36] was also selected as an experimental control factor, with acknowledgement that its representation apart from personality variables may introduce construct validity issues or conflation among the *Person Factors*.[37] As with *Intelligence* and *Experience*, there was no intention to evaluate decision-making performance for persons having low *Conscientiousness*.

1.4.2.3 Situational Variable Selection

WREM's situational variables were selected to permit representation of decision-

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[35] See Figure 1.2 above and Forgas (1995, p. 50).
[36] Conscientiousness is defined as a "quality of having positive intentions and carrying them out with care," (Landy and Conte, 2010, p. G-4). For purposes of supporting experimentation as a control factor, this definition was adapted to define the *Conscientiousness* factor in Study 1 as the measured or represented level of a decision maker's positive intentions as demonstrated by responsible behavior.
[37] Despite its inclusion as a top-level factor in the *FFM* (McCrae & Costa, 1985a; Gilboa & Revelle, 1994), conscientiousness is not identified as a subordinate trait for any of Eysenck's *PEN model* super-factors. Without acknowledging the factors' empirical validity, Eysenck conceded that conscientiousness fits "into the hypothetical nature of psychoticism" (H. Eysenck, 1991a, p. 782).

making situations with respect to the physical, psycho-physical, social and structural aspects of a decision-making event. Factors related to these aspects of a situation are well established as having impacts on an individual's cognitive performance (Salvendy, 1997; De Houwer & Tibboel, 2010; Sommerville, 2005; Pfister & Bohm, 2008; Wickens & Holland, 2000; Dawes & Messick, 2000; Zajonc, 1966; Myers & McCaulley, 1985).

As a group, the *Situational Factors* were originally inspired by observation and analysis of military decision-making events in Afghanistan.[38] These factors were further refined through consideration of the embedded factors of *AIM* (Forgas, 1995), the *Vroom-Yetton model* (Vroom & Jago, 1988) and concepts for *Situational Strength* (Meyer & Dalal, 2009; Meyer, Kelly & Bowling, 2017). Four *Situational Factors* were ultimately selected for inclusion as independent variables representing physical stimulation (*Environmental Stimulation*), deliberative process structure (*Process Structure*), decision-support group characteristics (*Support Group*) and the nature of the target problem (*Decision Typology*).

Environmental Stimulation was established to account for the potential effects of sensory stimulation on the decision maker's cognition. This class of external (or bottom-up) informational inputs to cognition has been demonstrated to produce significant effects on judgment, behavior and mood including changes in arousal, affectivity, productivity and self-control (Sommerville, 2005; D. Jones & Broadbent, 1987; Cushman & Crist, 1987; Rohles & Konz, 1987). 'Auditory', 'visual' and 'haptic \ other' were selected as its subfactors from among the five primary human senses. Taste and smell were not included

[38] This occurred as research in support of PhD program requirements at the Georgia Institute of Technology, Stewart School of Industrial and Systems Engineering. This research concluded with an unpublished report entitled "Identifying exploitable personality factors for decision making" (Dickens, 2007). Section 1.5.1 of this chapter provides a summary of that research activity.

based on an assessment that these two senses would not be systematically affected within and across typical decision-making contexts.

Process Structure was selected for inclusion as an independent variable to ensure that the effects of psychologically meaningful sources of stimulation were provisioned in the conceptual model. The imposition of a decision-making methodology or specified processes is known to greatly affect decision-making behaviors (Klein, 1996; Marks, Mathieu & Zaccaro, 2001). Decision-making processes can take many forms from ad hoc, intuitive/heuristic and unstructured to rigorously analytical and prescriptive. In addition, the enacted processes themselves may depart significantly from prescribed or intended processes, depending upon the rigor by which the process is enforced or adapted (Klein, 1989; Payne, Bettman. & Johnson, 1992; Marr, 2000). This has also been the subject of continuous and intensive debate within the U.S. military (Sorrells et al., 2005; Marr, 2000; Klein, 1996; Kem, 2009a) and the original inspiration for this entire body of research as discussed in Section 1.1.1 above.

As the last situational factor, *Support Group* was selected to provide representation for key aspects of the social group established in support of the decision maker's deliberative processes. The *Vroom-Yetton model* firmly establishes the importance of this variable with respect to the protection of a decision's technical quality and the probability of subordinate commitment to its implementation (Vroom & Jago, 1988; Vroom & Yetton, 1973). Beyond this, it is generally accepted that a variety of group and team attributes will have effects on team behavior and thus, by extension, the decision maker's behavior and cognition (Landy & Conte, 2010; Guzzo & Dickson, 1996; Stevens & Campion, 1994; Marks, Mathieu & Zaccaro, 2001). Three subfactors were adopted from the criteria provided by the *Vroom-Yetton model* including ‘subordinate information’, ‘goal congruence’, and ‘subordinate conflict’ (Vroom & Jago, 1988). The fourth subfactor – ‘social composition’ – was developed to round-out the representation of social conditions by including aspects for group size, familiarity and the interactive dynamic.

It was also anticipated that the examination of three specific interactions involving these variables (i.e., the *Neuroticism:Environmental Stimulation*, *Psychoticism:Process Structure* and *Extraversion:Support Group* interactions) would permit testing for the significance of the relationships between these three pairs of variables (D. Jones & Broadbent, 1987; Wickens & Holland, 2000; Zajonc, 1966; Ludvigh & Happ, 1974; H. Eysenck, 1998). If confirmed through experimentation, it was estimated that these relationships would greatly simplify the logic of situational control.

The last *Situational Factor* included in *WREM* provided for the representation of the judgment target. *Decision Typology* was selected as an independent variable to represent qualitative aspects of the underlying problem prompting a decision. This variable was included out of recognition of the human performance implications for judgments taken under variably complex, ambiguous, novel, time-constrained or risk conditions. (Goodie & Young, 2007; G. Wu, Zhang & Gonzalez, 2004; Staal, 2004; Shanks, 2006; Tversky & Kahneman 1974; Huber & McDaniel, 1986; Joslyn & Hunt, 1998; Smock, 1954). The component attributes of this variable were further identified as ‘urgency’, ‘complexity’, ‘atypicality’, ‘criticality’ and ‘uncertainty’.

The selection of these attributes was directly supported by the factors comprising *AIM* as they reflect criteria for the judge’s access to a ‘substantive processing strategy’

(Forgas, 1995).[39] The selection of the 'criticality' attribute was further supported by the *Vroom-Yetton model*'s 'quality' and 'commitment' requirements, which indicate that less-important decisions do not warrant the same investment in control as more-important ones (Vroom & Jago, 1988). However, because decision-making performance for unimportant, simple or familiar judgment targets was not seen as relevant to this research effort, the *Decision Typology* variable was employed only as a control factor for this research. It was considered that the decisions of interest needed to be critical enough to justify the effort required for control, urgent enough that they must be decided and not deferred, and complex enough that there would be a requirement for substantive processing (Forgas, 1995). As such, *Decision Typology* and its component attributes were set at high levels for employment as factors and subfactors in Studies 1 and 2.

Throughout the literature, there were many other situational/contextual attributes that might have been included among the *Situational Factors* (Forgas, 1995; Meyer et al., 2009; Salvendy, 1997; Karwowski, 2001). However, the inclusion of other top-level factors was assessed as impractical at this stage of *WREM*'s development and testing.

Once selected, these variables supported the establishment of *WREM* as a conceptual model. However, further refinement was required for their effective use as experimental factors. These refinements are detailed in Section 2.5 of Chapter 2.

1.5 Research Activities

The series of investigations comprising this body of work began with a literature

[39] Among the four cognitive processing strategies represented in *AIM*, only the substantive processing strategy entails elaborate and intensive consideration of the 'judgment target' (Forgas, 1995, p. 48).

review accompanied by the formal, field observation of military decision-making events. These activities led to the analysis and selection of prospective model components and their integration as a conceptual model. Testing and refinement of the conceptual model occurred over two experimental studies. The results of that experimentation supported the development of response contours modeling the variation in decision-making performance predicted by *WREM*'s component factors and their interactions. These response contours provided the basis for development of a system of personality-based situational controls designed to optimize decision quality.

1.5.1 Summary of Field Observations and Findings

As the first formal research activity, 100 real-world military decision-making events were non-intrusively observed and evaluated for evidence of interactive effects between 14 cognitive tasks (Crandall, Klein & Hoffman, 2006) and 57 personality-related stimuli derived from analysis of the *Meyers-Briggs Type Indicator* (Myers & McCaulley, 1985, 1998). This was predicated on a hypothesis that better decisions would result when personality-based preferences of individual decision makers were accommodated within a military decision-making process.

This research activity applied non-experimental adaptations of *Cognitive Task Analysis* (Crandall, Klein & Hoffman, 2006; Klein, 1989, 1996), the *Critical Decision Method* (Klein, Calderwood & MacGregor, 1989; Hoffman, Crandall & Shadbolt, 1998) and *Naturalistic Decision Making* (Klein, 2008) to examine the effects of selected situational stimuli on decision-making performance. Each of the observed events related to a critical, time-sensitive, novel and complex military mission required for approval by the senior commander or his deputy.[40]

The results were inconclusive due to several issues. Overall, there was poor evidence of decision-maker engagement with the expected *CT*s and low occurrence of the expected situational stimuli. Adding to this, there was extremely low variation in the decision-making results.[41] As such, the variation in response could not be correlated with variation in the situational factors as stimuli. However, this series of observations did inspire a sense that the personality-driven interplay between event participants, the circumstances and the deliberative content deserved re-examination under refined methods and conditions. This field research culminated in an unpublished report (Dickens, 2007).

1.5.2 Summary of Study 1 Experimentation and Findings

As detailed in Chapter 2, Study 1 was the first of two experimental studies supporting this body of research. The original version of *WREM* provided the conceptual basis for the development of an experimental design. However, due to the hypothetical nature of the decision-making events, *Decision Quality* was accepted as a proxy for *Decision Effectiveness*. The results firmly established the significance of *WREM*'s personality and situational factors as independent variables affecting organizationally supported decision making.

The primary objective of this study was to establish that subjects would assess that

[40] These decision-making events occurred between February and December 2007 in Kabul, Afghanistan. These were required by U.S. military authorities for final approval of counterterrorism missions.
[41] The response variable for these decision-making events was established as a categorical variable with three categories including ‘approved’, ‘approved with directed changes’ and ‘disapproved’. No observed events were ‘disapproved’, with one ‘approved with directed changes’ and 99 ‘approved’ as recommended.

decision makers produce better decisions when the supporting circumstances are aligned to their personalities. It was expected that this study would confirm the significance of main effects related to six core experimental factors on the experimental response.

Three personality factors and three situational factors were established as independent variables in a modified 3^3 X 3^2 experimental design (C. Wu & Hamada, 2009).[42] The 56 treatment combinations were then prepared for administration as repeated measures by use of word pictures representing the factors at the designed levels.

The study was completed through the development, implementation and analysis of an online survey with 233 respondents, most of whom were U.S. Department of Defense and defense industry professionals. Each of 56 experimental events were established by induction as *thought experiments*[43] (Brendel, 2004; Gendler, 2011; Clement, 2008) through use of word pictures composed of descriptive aspects of each decision-making event required for assessment.

After presentation of the stimuli, subjects were prompted to assess probable decision quality as the experimental response. Scenarios were presented as repeated measures, sequenced in eight experimental blocks defined by the combinations of situational factors. At the conclusion, subjects were required to assess the relative criticality of eight controls aimed at the improvement of decision-making quality as an adaptation of

[42] The 3^3 full-factorial array of personality factors was modified by excluding the 20 points where two or more personality factors was set to either high or low. This produced seven points of examination for personality factors (see Figure 2.1). These were further combined across the eight points of the 3^2 full-factorial array of situational factors. The resulting design was balanced, with examination gaps where more than one personality factor was offset from the moderate strength level.
[43] The ‘gedankenexperiment’ or *thought experiment* is used to establish theories or as proxies for physical experimentation (Brendel, 2004; Gendler, 2011; Clement, 2008; Hogan, 2010; Kuhne, 2005).

the *policy-capturing* method (Aiman-Smith, Scullen & Barr, 2002; Karren & Barringer, 2002; Brehmer, 1988; Zedeck, 1977).

A total of 114 subjects and 6,384 experimental runs were accepted as valid. Post hoc evaluation confirmed the statistical significance of all six experimental factors. The analysis also produced indications of three significant interactions between fixed-factors, providing insights for the further evaluation and refinement of *WREM*. With respect to the assessments of control options, all eight were perceived by a plurality of subjects as relatively critical, with controls over the 'decision-making process' and 'decision-maker state' indicated as especially important. As compared to the other control options, the variance in the subjects' responses for control over 'participant goal congruence' was notably high, which suggested some general disagreement over the need for this specific situational control.

By these results, the general hypothesis of this study was confirmed. According to the judgment of this study's subjects, specific situational factors do variably affect decision quality according to the personality of a designated decision maker. Notwithstanding the predominance of personality factor effects over situational factor effects revealed in the regression model used in the study's analysis, the six core experimental factors established the basis for the further testing of *WREM* as a conceptual model.

1.5.3 Summary of Study 2 Experimentation and Findings

As detailed in Chapter 3, Study 2 was the second of two experimental studies supporting this research. This study verified the significance of key personality and situational factor interactions affecting organizationally supported decision making. Fixed-factors, control factors and the response variables were the same as employed for Study 1.

The objective of this study was to establish *WREM* as a parametric model by confirming the scope of effects arising from personality and situational factor interactions on the experimental response. This was needed to reveal the optimal personality-situation alignments that would form the basis for a practical system of control. Eleven separate interaction effects were included for testing.

The six core experimental factors were established semi-randomly as independent variables in a unique experimental design, that was hybridized to incorporate fixed and random-imputed-as-fixed-factors. This allowed for examination of 108 treatment combinations, six of which were established by fixed-factors and 102 generated by subject data imputed as fixed-factors.[44] The resulting design was imbalanced, with thin coverage of low *Psychoticism* and low *Environmental Stimulation*. Semi-randomized selections of the treatment combinations were then administered as repeated measures by use of word pictures and scenario narratives representing the experimental factors at the levels specified for each scenario.

A total of 171 respondents were recruited for participation from U.S. Department of Defense organizations, defense industry professionals, private industry, academic professionals and graduate students. Like Study 1, this experiment was completed through an online survey. Events for assessment were established by induction in a semi-

[44] The 102 hybrid design points were developed through imputation of each subject's personality measures for the personality fixed-factors of each experimental scenario. Additional subjects would have introduced additional hybrid design points.

randomized sequence with narratives and word pictures used as representations of seven decision-making scenarios. After subjects were presented with each scenario's stimuli, they were prompted to assess probable decision quality as the experimental response, and then to reassess probable decision quality with themselves substituted for the scenario-based decision maker. Each subject was required to complete between three and thirteen experimental runs, depending on their willingness to continue. This produced 22 validated subjects and 182 experimental response data.

An additional feature of this survey was that three situational control options were required for consideration after each event assessment as a second adaptation of the *policy-capturing* method (Aiman-Smith, et al., 2002; Karren & Barringer, 2002; Brehmer, 1988; Zedeck, 1977). These were each described as options to exert control over event stimulation related to the three fixed situational factors. This produced 546 control policy assessment data across the 22 subjects.

When the experimental response data were examined in a hierarchical mixed effects model, significant factor interactions implicated four of the six independent variables as necessary components in the hierarchy of fixed effects. However, none of the six independent variables demonstrated significance by their main effects alone, thus demonstrating that they had been fully mediated by the factor interactions.[45]

By analysis of the 546 control policy assessment data, all three situational factors indicated significant main effects on the recommendation for at least one control policy

[45] Separate evaluation by mixed models that excluded factor interactions provided additional evidence of statistical significance at $p < 0.05$ for the main effects of three independent variables. Two others could only be confirmed as significant where they were evaluated as single predictors of the response. However, no alternative models indicated statistically significant main effects for the sixth variable: *Neuroticism*.

and none of the three personality factors did so. However, as with the analysis of the experimental response data, significant factor interactions implicated all of *WREM*'s core factors except *Neuroticism.*

The combined results of the experimental and *policy-capturing* analyses strongly supported the continued inclusion of five of the six core experimental factors as *WREM* components. The scarcity of direct evidence for significant main effects was taken to confirm the logic of *WREM:* that there would be no particular advantages associated with any one personality or situational factor except as those factors interact to support or inhibit good decision making. The compelling results of Study 1 provided support for the retention of the *Neuroticism* as a factor in *WREM,* pending further evaluation. Mixed-model regression coefficients were accepted as estimation parameters for *Decision Quality* and provided the basis for the establishment of *WREM* as a parametric model.

1.5.4 Summary of WREM Response Surface Analysis

As detailed in Chapter 4, *WREM'*s parameters were used to support the development of a *system of situational control* for the optimization of decision-making performance according to the personality of the decision maker. These analyses applied selected techniques borrowed from response surface methodology (Kutner, Nachtsheim, Neter & Li, 2005; C. Wu & Hamada, 2009; and Law, 2007), which led to the identification and evaluation of *optimization solutions* that were uniquely applicable to different combinations of personality factors.

The *WREM* response surface was analyzed in both deterministic and stochastic versions to obtain specific insights about optimal situational conditions for each personality factor combination and to analyze the sensitivity of those optimal conditions to uncertainty. Through quantitative analysis of the response surface data, prospective *optimization solutions* were established for each personality factor combination. These were conditionally validated by examination of response contours and their supporting data. After applying the *system of situational control* as a constraint on the generation of an optimized response surface, the results revealed dramatic improvements to two measures of performance: *mean(Decision Quality)* and *minimum(Decision Quality)*.

Based on the results of these analyses, the *system of situational control* was tentatively accepted as an accompaniment to *WREM*. However, due to the recognized limitations of the research methods and results, these were recommended for further examination in the context of actual, organizationally supported decision-making events.

1.6 Introduction Chapter Summary

The following chapters report the details of the two main experimental studies forming the core of this body of research and the exploitation of those studies' results through development of a practical and testable *system of situational control*. From these, the reader should conclude that personality attributes are critical factors affecting organizationally supported decision making and that the implications of these factors on *Decision Quality* are heavily weighted in their interactions with situational factors.

The primary limitations of this research include: the reliance on *thought experiments* as a proxy and precursor for physical experimentation; the dominance of age and experience among the subject pools; and the use of selected factors as experimental controls that are known to affect cognitive performance. The final chapter of this report will address these and other limitations more thoroughly.

Beyond *WREM* itself, other key innovations delivered through this research were: the development of *trait dimensional scales* for selected personality traits linked to the PEN model (H. Eysenck, 1990, 1998); the employment of a unique random/fixed-factor (hybridized) experimental design; and the employment of a stochastic simulation of an experimental survey.

At present, the primary burden of control over decision-making circumstances lies with the decision makers themselves. Lacking access to practical and holistic theories for control, and compelled by their personal preferences, they are at a distinct disadvantage to select and apply situational controls that might maximize the quality of their decisions. The same disadvantage holds true for organizations.

Generals Lee and Meade had only the council of war as a means to exert control over the quality of their fateful decisions (Coddington, 1968; Shaara, 1974; Cleaves, 1991). Apart from their personal preferences and prior experience, they would have known almost nothing about why they should opt for or against any form of control. Regrettably, today's decision makers and organizations operate under the same 19th century limitations. Despite more than a century of progress among the decision sciences, there still exists no systemic logic for personality-informed situational control over decision-making circumstances.

WREM changes that by taking advantage of what is already known about decision making, integrating the existing concepts and theories, and giving decision makers and organizations a simple set of controls that subordinate the decision-making process to the decision maker, and better assure the outcomes. As the integration and adaptation of concepts, processes and models revealed across the decision sciences, *WREM* supports the improvement of cognitive performance by use of practical, personality-based situational controls. Its evaluation through two experimental studies, response surface analysis and stochastic simulation clearly indicates that the dividends may be significant. Beyond this, the results of this research are sufficient to suggest that *WREM* may have direct applicability to military, government, finance and other domains where decisions can be improved by exploiting the personality characteristics of decision makers by the adaptive control of situational conditions.

CHAPTER 2. PERSONALITY FACTORS IN DECISION MAKING (STUDY 1)

2.1 Introduction

As the first of two experimental studies, Study 1 established the practical and statistical significance of key personality and situational factors affecting organizationally supported decision making. These factors were analyzed in the context of the *War Room Effects Model* (*WREM*), with an aim to validate the conceptual model's basic composition and permit its further development as a parametric model.

WREM was established as a conceptual model of organizationally supported decision making. As described in Chapter 1, it was conceived as the theoretic integration and adaptation of the *Affect Infusion Model* (*AIM)* (Forgas, 1995, 2017), the *Vroom-Yetton model* (Vroom & Jago, 1988), *Situational Strength* (Meyer et al., 2010; Meyer, Kelly & Bowling, 2017), the *Yerkes-Dodson law* (Wickens & Holland, 2000) and the *PEN model* of personality (H. Eysenck, 1998).

Decision-making contexts applicable to *WREM* were anticipated to include those where a single individual is established as responsible to decide on behalf of an organization, and where this individual is supported in their role by organizational resources including processes, facilities and personnel. This study tested a general hypothesis that specific situational factors variably affect cognitive performance according to the personality of the designated decision maker.

WREM is comprised of 15 variables, with three personality variables and three situational variables established as its core factors. The three personality variables (*Psychoticism, Extraversion,* and *Neuroticism*) were drawn from H.J. Eysenck's *PEN model* of personality (H. Eysenck, 1998).[46] The three situational variables (*Environmental Stimulation, Process Structure* and *Support Group*) were developed through the integration of concepts drawn from various sources across personality psychology, social psychology and business management. Detailed discussion of the selection and development of these factors is provided in Chapter 1, Section 1.4.

This study was completed through the development and implementation of an experiment conducted as an online survey[47] with 114 subjects recruited from students, faculty and associates of U.S. military professional education institutions and graduate business colleges. The survey elicited subject assessments of decision-making performance for 56 decision-making scenarios.

No actual decision-making events took place to support this study. Events were established only by induction through use of word pictures composed of descriptive aspects of each event required for assessment. Word pictures displayed combinations of text-based stimuli groups representing the six fixed-factors of primary interest. Three of these groups established representation for the decision maker's personality while three others established representation for the situational characteristics of the decision-making events.

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[46] See footnote 30.
[47] A copy of the survey entitled "Assessment of Decision Making for Different Situations" is included as a supplementary file to this report.

Four control factors were included in the stimuli to round-out the representation of the scenarios. After presentation of each scenario's stimuli, subjects were prompted to assess probable decision quality as the experimental response. Scenarios were presented as repeated measures in a semi-randomized sequence in eight experimental blocks.

Upon completion of the survey, a total of 6,384 experimental runs were accepted as valid. Post hoc evaluation confirmed the significance of five of the core factors, with the sixth implicated by a significant factor interaction. The analysis also reported other significant factor interactions, providing important insights for the further examination of personality and situational effects in decision making.

2.2 Experimental Factors

From the variables established in *WREM*, one mediating variable and nine independent variables were selected as experimental factors, along with one additional control factor not explicitly included in *WREM* (*Conscientiousness*[48]). The mediating variable was designated as the experimental response. Four independent variables were established as experimental controls *WREM*'s personality and situational variables comprised the six remaining independent variables.

Decision Quality was selected to be the experimental response as an alias for *Cognitive Performance* and as a proxy for *WREM*'s dependent variable (*Decision Effectiveness).* This was decided because the decision-making events used as the basis for assessment of the response were not planned for hypothetical implementation.

[48] Chapter 1, Section 1.4.2.2 provides the rationale for the selection of *Conscientiousness* as a control factor and the implications of its inclusion for the representation of personality factors.

Psychoticism, *Extraversion* and *Neuroticism* were selected as the independent variables representing decision-maker personality. *Environmental Stimulation*, *Process Structure*, and *Support Group* were selected to represent situational conditions. And finally, *Intelligence*, *Experience*, *Conscientiousness and Decision Typology* were included as experimental control factors.

Following are the definitions established for the experimental factors as adaptations to the definitions provided at Section 1.2.3 of Chapter 1.

- *The Experimental Response:* This dependent variable was collected as a subject response on a Likert scale.

    Decision Quality (DxQual)[49] – The subject's assessment of the probable quality of a decision made at the culmination of a decision-making event without regard for its implementation.

- *Independent Variables:* These factors were established through use of stimuli representing factors at the strength levels required by the experimental design.

- Personality Factors

    - *Psychoticism* (*Psych*) – The measured or represented level of the decision maker's tendency for aggression and for having (or not having) psychotic episodes or breaks with reality. C*reative* and *tough-minded* were assigned as subfactors to support representation of *Psych*.

    - *Extraversion* (*Extrav*) – The measured or represented level of the decision maker's tendency for positive affectivity and for social and external engagement. *Sociable* and *assertive* were assigned as subfactors to support representation of *Extrav*.

    - *Neuroticism* (*Neuro*) – The measured or represented level of the decision maker's tendency for emotionality or negative affectivity. *Anxious* and *emotional* were assigned as subfactors to support representation of *Neuro*.

[49] This variable is also referred to in *WREM* as *Cognitive Performance*. See Section 1.4.1 of Chapter 1.

- Other Decision-Maker Attributes as Factors

    - *Intelligence* – The measured or represented level of a decision maker's mental abilities. This was developed for use as a control factor and set to a high level for this study.

    - *Experience* – The measured or represented level of the decision maker's task-relevant experience. This was developed for use as a control factor and set to a high level for this study.

    - *Conscientiousness*[50] – The represented level of a decision maker's positive intentions as demonstrated by responsible behavior. This was developed for use as a control factor and set to a high level for this study.

- Situational Factors[51]

    - *Environmental Stimulation (EnvStim)* – The represented level of sensory stimulation produced by environmental and physical sources within a decision-making event. The three subfactors established in Chapter 1 to support representation of *EnvStim* were *auditory*, *visual*, and *haptic/other* stimulation.

    - *Support Group (SptGrp)* – The represented level of interpersonal and interactive stimulation produced by a social group established to support a decision-making event. The four subfactors established in Chapter 1 to support representation of *SptGrp* were *subordinate information, goal congruence, subordinate conflict* and *social composition.*

    - *Process Structure (ProStruc)*– The measured or represented level of stimulation produced by the deliberative approach or problem-solving method imposed on a decision-making event. The three subfactors established in Chapter 1 to support representation of *ProStruc* were *logic*, *rigor* and *clarity*.

    - *Decision Typology* – The categorization of decisions according to characteristics of the problem requiring a decision. This was developed for use as a control factor. The five subfactors established in Chapter 1 to support representation of *Decision Typology* were *urgency*, *complexity*,

[50] See footnote 36.

[51] As discussed in Chapter 1, Section 1.4.2.3, attributes were previously assigned as subfactors to *WREM's* situational factors to support their effective representation during experimentation.

novelty/typicality, *criticality* and *uncertainty/ambiguity*. All subfactors were set to represent the factor at a high level.

These experimental factors were further developed to support their use in the experimental stimuli as discussed in Section 2.5 below.

2.3 Study Hypotheses

The primary objective of this study was to establish that decision makers make better decisions when the supporting circumstances are aligned to their personalities. It was expected that this study would confirm significant main effects on the experimental response from the six core experimental factors. In addition, it was anticipated that the main effects for two of the personality factors (*Psych* and *Extrav*) would indicate increases in the response as these factors increase, while *Neuro* would indicate decreases (D'Zurilla, Maydeu-Olivares & Gallardo-Pujol, 2010). The experimental results were also expected to confirm the significance of the core factors through key personality/situational factor interactions. More specifically, the formal experimental hypotheses were as follows:

- H_P (*Psych*): *DxQual* will improve as decision-maker *Psych* increases.
- H_E (*Extrav*): *DxQual* will improve as decision-maker *Extrav* increases.
- H_N (*Neuro*): *DxQual* will decrease as decision-maker *Neuro* increases.
- H_C (*EnvStim*): Changes to *EnvStim* will have a non-zero effect on *DxQual*.
- H_S (*ProStruc*): Changes to *ProStruc* will have a non-zero effect on *DxQual*.
- H_G (*SptGrp*): Changes to *SptGrp* will have a non-zero effect on *DxQual*.
- H_{PXS} (*Psych:ProStruc*): Changes to *Psych* and *ProStruc* will have a non-zero interaction effect on *DxQual*.

- H_{EXG} (*Extrav:SptGrp*): Changes to *Extrav* and *SptGrp* will have a non-zero interaction effect on *DxQual*.

- H_{NXC} (*Neuro:EnvStim*): Changes to *Neuro* and *EnvStim* will have a non-zero interaction effect on *DxQual*.

Because this investigation was designed to set conditions for further examination of *WREM*, the level of significance for rejection of the null hypothesis was set at $p < 0.10$ for main effects and $p < 0.25$ for factor interactions. Given the volume of experimental noise expected to saturate the response, other potentially key factor interactions were not formally considered for inclusion among the hypotheses. However, these were planned for post hoc analysis to set conditions for subsequent experimentation in Study 2.

2.4 Study Methodology

2.4.1 Survey Description

This study was conducted as a repeated measures stimuli-response experiment by survey. It was administered through the commercial services of Zoomerang.[52] Decision-making events were established by induction as *thought experiments*[53] through use of word pictures composed of descriptive aspects of the events required for assessment. Word pictures displayed combinations of lexical (text-based) descriptors and descriptor groups representing the six core experimental factors and four control factors. These were presented in a manner that would facilitate an automated versus consciously controlled response to stimuli by subjects (Jacoby, 1991; Curran & Hintzman, 1995).[54]

[52] The study was approved for experimentation with human subjects by the Georgia Institute of Technology Institutional Review Board in October 2011.
[53] See footnote 43.
[54] Details related to the development of the stimuli are discussed in Section 2.6 below.

There was no prescribed time or other conditions for subject participation. Upon completion of consent protocols and the entry of subject classification data, subjects took the survey at their own pace. As the experimental component, they were required to sequentially assess the probable quality of decisions that would be made in 56 scenarios. These were rated on a scale from 'Very Bad Decision' to 'Very Good Decision'. Upon completion of all scenarios, subjects were required to rate the relative importance of eight control policies as applicable to all scenarios.[55] To conclude their participation, subjects were required to complete an 18 item subject personality measure, a four item subject experience measure and a seven item subject knowledge measure. The survey was designed to take an estimated minimum of 25 minutes and a maximum of 45 minutes for completion. There were no subject options for partial completion.

2.4.2 Experimental Design

The experimental design for this study was a modified 3^3 x 3^2 design with six independent variables. Low, moderate and high levels were established as settings for the personality factors. Seven design points from the full-factorial personality factor design array were selected by excluding all combinations where two or more factors were either high or low. These exclusions were justified by run size economy alone (C. Wu & Hamada 2009). This decision was further supported this researcher's sense – confirmed during survey item development and pilot testing – that having more than one personality factor simultaneously set at high or low would make it difficult for subjects to estimate positive

[55] The assessment of controls applied an adaptation of the *policy-capturing* technique, which solicits analyses and judgments from qualified persons based upon the presentation of relevant cues regarding a judgment target. These solicited judgments provide an aid in the analysis and development of policies related to similar judgment targets (Karren & Barringer, 2002; Cooksey, 1996; Brehmer, 1988; Zedeck, 1977). Some limitations of *policy capturing* are reported in Roehling (1993).

decision-making performance. This process resulted in the selection of seven personality factor combinations that were balanced across the 27-point full-factorial array.

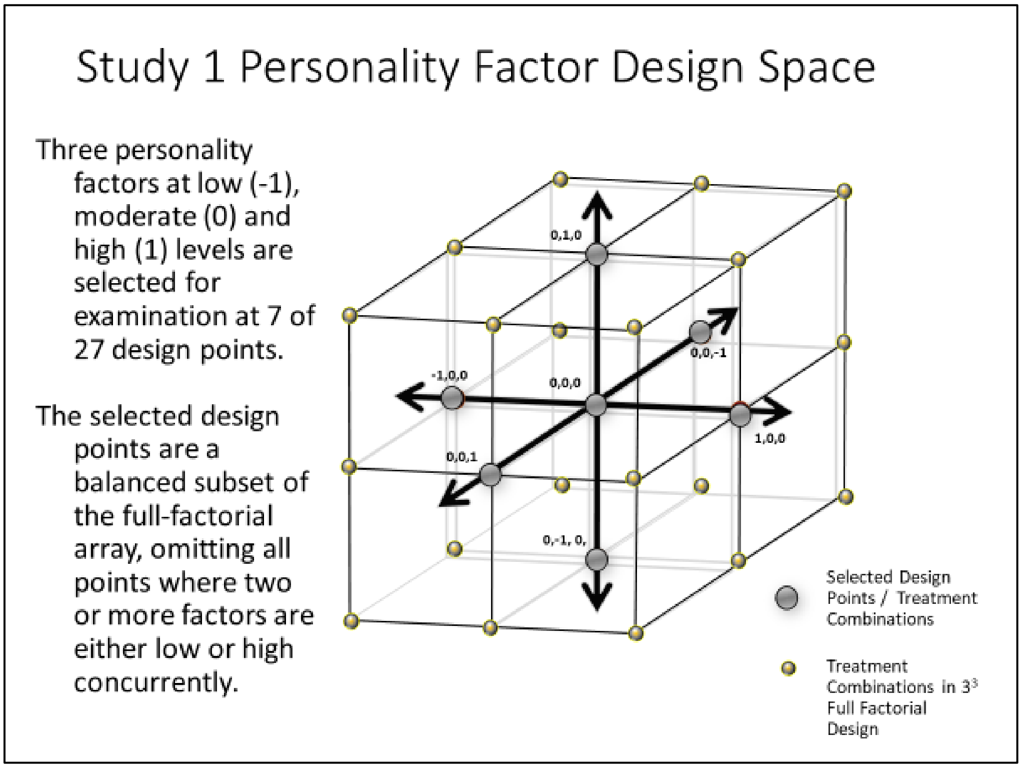

Figure 2.1: Study 1 Personality Factor Design Space

The above figure illustrates the personality factor design space with the selected points.

Given the still-large run-size implications of combining a 7-point personality factor array with a three dimensional situational factor array, it was decided that the situational factors would be examined at two levels each. This particular decision precluded any possibility of detecting complex or non-linear relationships between situational stimulation and decision-making performance as would be predicted by the *Yerkes-Dodson law* (Wickens & Holland, 2000).[56] Nonetheless, there were no other practical means to

[56] See discussion at Section 1.3.2.1 of Chapter 1.

economize further on the run size without carving more deeply into the personality design space or reducing the number of situational factors. The three situational factors were thus each set to either high or low levels and planned for full-factorial examination.

Personality and situational factors were further combined to produce the final experimental design, indicating the requirement for examination of 56 design points. Although balanced and relatively economical, this design imposed obvious limitations on obtaining support for inferences about the unexamined and underexamined gaps in the design space or the possible curvilinear nature of situational factor effects and interactions. It was decided that subsequent research would attempt to address these issues. The experimental design matrices for this study is available at Appendix A.

2.4.3 Subjects

Survey recruitment primarily targeted mid and late-career U.S. military officers and civilian national security professionals who, through practice and professional education, were expected to have extensive exposure to formal, organizationally supported decision-making processes. As a secondary priority, career business professionals and executive graduate business students were included to improve the generalizability of the study's results. Despite the relatively narrow scope of the recruitment strategy, there were no criteria for exclusion of other prospective subjects from this study. The results of this recruitment effort are discussed below in Section 2.6.1.

2.5 Factor Development

It was determined that further development of the experimental factors was required to ensure their effective use as stimuli in the survey instruments. This largely entailed the identification of lexical representations – or descriptors – of the subfactors at strength levels dictated by the experimental design. The analyses of Norman (1967) and Saucier (1997) were key sources of personality subfactor descriptors, while the literature related to the *Affect Infusion Model* (Forgas, 1995, 2017; Mao, et al., 2018), *Situational Strength* (Meyer et al., 2009; Meyer, Kelly & Bowling, 2017) and the *Vroom-Yetton model* (Vroom & Jago, 1988) were key sources for the identification of situational subfactor descriptors. The following sections detail the selection, analysis and further development of these descriptors into the stimuli components required to support the scenarios of this survey.

2.5.1 Personality Factor Development, Descriptor Pairs and Groups

Despite the inherent simplicity of the *PEN model*, the related literature provided little suggestion of any means to directly represent the super-factors as experimental stimuli. It was seen as impractical to employ the super-factor definitions as stimuli because of inconsistencies in their composition and the need for their revision for use at multiple factor levels. Some other form of factor representation was required if valid, consistent and sufficient decision-maker percepts were to be stimulated in the subjects.

The vast numbers of measurement items warded against use of the formally established *PEN model* measures[57] as an aid to stimuli development. Beyond this, it was estimated that simulating or 'spoofing' the personality measures on behalf of hypothetical decision makers would have been fraught with validity hazards and still might not have delivered useful insights for development of the required multi-level personality stimuli.

[57] The *Eysenck Personality Questionnaire* (*EPQ*) and the *Eysenck Personality Profiler* (*EPP*) are the personality measures established for the *PEN model*. Both are available in full and abbreviated-versions. (H. Eysenck & S. Eysenck, 1975; H. Eysenck & Wilson, 1991; Francis & Jackson, 2004).

Instead, it was decided that the necessary factor representations would be composed of lexical descriptors reflecting the personality factors at the required fixed levels.

The *PEN model* super-factors were thus decomposed into the signal characteristics[58] of each as a framework for development of personality descriptors as stimuli. Two signal characteristics were selected for each personality factor. These were obtained by consideration of the established concepts for the *PEN model* (H. Eysenck, 1998), the 21 traits aligned against the *PEN* super-factors in the *Eysenck Personality Profiler* (H. Eysenck & Wilson, 1991). This was also supported by an extensive review of literature related to the *PEN model*'s super-factors' correlations with variously established personality traits (Eaves & H. Eysenck, 1975; John, 1990; Wiggins & Trapnell, 1990; McCrae & Costa, 1985a; McCrae & John, 1992; Cattell, 1989; Hernandez & Mauger, 1980). Criteria for selection of signal characteristics for the personality factors included:

- their consistency with Eysenck's concept for the related super-factor.
- their distinctness from Eysenck's concepts for the other two super-factors.
- their distinctness from other signal characteristics.
- their relevance to judgment and decision-making tasks.
- their sufficiency as a representation for the respective super-factor when combined in a descriptor pair.[59]

[58] As a subset of established personality traits related to higher order factors or super-factors, 'signal characteristics' were established to prevent possible confusion between the selected set of attributes and any formally established sets of 'traits', inherent characteristics or attributes related to the referent factors. The term is similarly applied to the subfactors employed as situational factors.
[59] Two of the six signal characteristics established for personality factors required consideration of sources beyond the list of 21 *EPP* traits for *PEN model* super-factors. *Emotionality* was selected based upon its consistency with the seven *neuroticism* traits established by the *EPP* and because 'emotional stability' is

Signal characteristics selected to support personality stimuli development were *creative* and *tough-minded* for *Psych*, *sociable* and *assertive* for *Extrav*[60] and *anxious* and *emotional* for *Neuro*.

Clearly, a larger set of signal characteristics might have strengthened representation of the *PEN* super-factors. However, this would have presumed the average subject's ability to effectively absorb and process more complex personality stimuli. It was understood in advance that effective person-as-decision-maker percepts could not be imposed upon subjects. In fact, the personality stimuli would only evoke percepts that were uniquely formed by each subject's experience and constrained by their cognitive abilities.

Consideration for *Miller's Law*[61] (Miller, 1956) suggested that requiring subjects to consider more than six personality attributes would potentially tax the working memory of normative subjects beyond the '7 +/- 2' memory component maximum. Based on this, it was anticipated that requiring subjects to process at or beyond the limits of *Miller's* estimate of working memory capacity would have negatively affected their ability to form effective decision-maker percepts . It would have also competed with subjects' capacity to

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commonly used in place of the 'neuroticism' label within various *FFM* versions including the *Big Five* (Norman, 1963; and Digman 1990). *Creativity* was selected based upon its consistency with the seven *psychoticism* traits established by *EPP*, its identification in Acar & Runco (2012) and H. Eysenck & Furnham (1993) as having a significant correlation with *psychoticism*, and the potential implications of creativity for effective decision making.

[60] For *Extraversion*, three signal characteristics were originally considered including *sociable*, *assertive* and *expressive*. At the onset of the selection process, it was not clear whether *assertive* or *expressive* would be more useful as a subfactor given that these two characteristics appeared to be less distinct from one another at the low end of trait strength. *Expressive* was rejected after descriptor analysis indicated a poor distribution of viable descriptors at or near moderate trait strength.

[61] *Miller's Law* proposes that the average human can only process between five and nine (7 ± 2) objects in working memory (Miller, 1956). This research did not assume that 'working memory' was implicated by the stimuli any more so than other cognitive processes. However, the limitations on stimuli complexity were imposed as an acknowledgement that all of the cognitive processing tasks required by each experimental run would be affected by the limits of each subject's working memory.

process the numerous other stimuli components required to support each experimental run, or to maintain effective engagement with the overall assessment task. With 'percept' quality at stake, six personality data points were thus accepted as a compromise between the comprehensive representation of personality and the implications of placing excessive demands on subjects' attention and cognitive processing abilities.

Candidate lexical descriptors were then prepared for evaluation and selection according to the framework provided by the signal characteristics. Descriptors were selected for each characteristic at the estimated low, moderate and high levels of trait strength from the lexical analyses of Norman (1967) and Saucier (1997).[62] Each candidate descriptor was then evaluated against the seven aspects of abnormality established by Rosenhan & Seligman (1989 as cited by M. Eysenck, 1994) as a basis for their exclusion from further consideration as stimuli components.[63] Other descriptors were selected for exclusion-because-they were seen as evaluative (i.e., exclusively positive or negative).

However, this screening for abnormal or evaluative terms prevented the delivery of a sufficient distribution of descriptors for any of the signal characteristics, with gaps in representation for multiple traits at one or more of the three required strength levels. As

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[62] The body of literature among the psychological disciplines does not directly support the use of descriptors across the dimensions of personality traits with applicability to average or moderate trait strength. There is a bi-polar aspect of the trait descriptor continua among the lexical and factor analyses and personality descriptor lists. Saucier's (1997) study delivered rudimentary scales for both personality and intelligence by aligning descriptive terms according to their factor loadings for the associated personality trait or for intelligence. However, these ordered terms failed to provide descriptors at or near the norm/center of each scale (i.e., factor loading 0.0) leaving them most useful for representation of trait strength in the high and low ranges, and less useful for normative strength. Development of this study's *trait dimensional scales* was required to establish robust representation of traits at average strength.

[63] These disqualifying characteristics included: suffering; maladaptiveness; vividness and unconventionality; unpredictability and loss of control; irrationality and incomprehensibility; observer discomfort; violation of moral standards and ideals. Eysenck suggested that these were markers for abnormality (M. Eysenck., 1994, pp. 90-92).

such, certain candidate descriptors were appended by prefixes or adverbs (e.g., ‘un-’, ‘very’ or ‘somewhat’) to modify the descriptor trait strength from that conveyed by the original term. Some still-remaining gaps were finally resolved by the inclusion of synonyms, euphemisms or dysphemisms drawn from thesauri and dictionaries.

Ninety-eight descriptors were subjected to evaluation in batches for each signal characteristic.[64] Evaluators were required to assign a numeric strength to each descriptor on a seven point scale from ‘abnormal low’ (1) to ‘abnormal high’ (7).[65] They were also required to recommend for elimination any descriptors that were either inconsistent with their view of the referent trait or that might convey aspects of personality-based dysfunction. The following figure depicts the metric applied by evaluators in their task.

No Fit on This Scale	ABNORMAL LOW	NORMAL RANGE					ABNORMAL HIGH
				AVERAGE			
X	1	2	3	4	5	6	7
		ECCENTRIC			ECCENTRIC		

Figure 2.2: Descriptor Evaluation Metric

These evaluations required three iterations due to the rejection of descriptors by one or both evaluators and a scarcity of descriptors in the moderate strength range for selected traits.[66] Upon completion, a final set of 70 descriptors were accepted across the seven

[64] These students were doctoral candidates in the Georgia Institute of Technology School of Psychology. The collection instrument entitled “Trait Dimensional Scale Assessment” is included as a supplementary file to this report.

[65] The use of ‘abnormal’ was not intended to imply clinically diagnostic abnormality.

[66] Twenty-eight prospective descriptors were eliminated by recommendation of at least one evaluator. Both evaluators’ ratings for moderate trait descriptors established a basis for inference of a central tendency for each trait. In addition, several descriptors were evaluated as ‘eccentric’ on the metric, thus indicating dispersion. This was further indicated by the evaluators’ recommendations for exclusion of other terms due to connotations of abnormality. The evaluators’ sense of dispersion was consistent on all jointly accepted terms. Subject personality measures developed from the selected descriptors provided further support for the validity, central tendencies and dispersion of the scales where the indicated ‘normal’ range for each measured personality factor was approximately the factor mean+/- 2 standard deviations for each factor.

signal characteristics for personality. Cronbach's alpha for the descriptor evaluations was calculated at 0.801. The evaluator's separate assessments of the descriptors' trait strength were averaged, and these values were accepted as the scaled strength of the descriptor. The descriptors were further organized into seven *trait dimensional scales*.[67] After comparison with Saucier's (1997) study, the sequencing of descriptors in the *trait dimensional scales* was partially validated by the reported factor loadings of selected descriptors.[68]

For six of the seven dimensional scales, descriptors were identified across the estimated 'normal' range of trait strength (i.e., between 2 and 6 on the evaluation metric), with multiple descriptors clustered in low, moderate and high ranges. There were two exceptions. The dimensional scales for both 'emotional' and 'expressive' provided only one descriptor each near the respective scale's origin (i.e., between 3.5 and 4.5). This provided rationale for the deselection of 'expressive' as a signal characteristic for *Extraversion*, in favor of 'sociable' and 'assertive.' However, there was no third signal characteristic proposed for the *Neuroticism* factor. As such, minor adjustments were required. The *trait dimensional scale* for 'emotional' was amended to include 'moderately stable' and 'moderately emotional' as descriptors in place of 'emotional.' These were both assigned the same scaled strength as 'emotional' in order to provide the two descriptors at or near the moderate level of trait strength.

[67] These are available in the document entitled "Trait Dimensional Scales" included as a supplementary file to this report.

[68] Factor loadings from Saucier (1997) were only available for nine of the 36 final descriptors. 'Assertive' and 'dominant' were evaluated on the *trait dimensional scale* in reverse order of their published factor loading: The *trait dimensional scale* ratings and factor loadings reported by Saucier were 4.5/0.39 ('assertive') versus 5.5/0.49 ('dominant'). This discrepancy was deemed acceptable given that the factor loading disparity was small, and that Saucier's factor loadings were reported against extraversion as a higher-level factor, and not for the specific trait (assertive) represented by the respective dimensional scale.

From each of the six final scales, two descriptors were selected at each level required for representation in the experimental stimuli. The criteria for selection were that the scaled strengths fell between 2 and 3.5 for low-strength descriptors, between 3.5 and 4.5 for moderate-strength descriptors, and between 4.5 and 6 for high-strength descriptors. Where more than two descriptors met these requirements at any one strength level, the descriptors with estimated strengths closest to 3, 4 and 5 were selected for use as low-, moderate- and high-strength descriptors respectively.

This produced the final set of 36 descriptors required for redundant representation of the six signal characteristics/personality traits at low, moderate and high levels. These descriptors were then evaluated in strength-level pairs for relative likability.[69] Descriptor likability ratings were derived from 'desirability' ratings provided in Norman's (1967) analysis and the comparable 'likability' ratings from Saucier (1997).[70]

After comparing likability ratings for the descriptors in each pair, higher-rated descriptors were designated 'more likable' and lower-rated descriptor were designated 'less likable'. Descriptors not rated for likability/desirability by Norman's or Saucier's analyses were treated as neutral with respect to likability. The following table depicts the selected descriptors and their likability ratings.

Table 2.1: *PEN Model* Trait Descriptors[71]

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[69] The decision to adopt 'more likable' and 'less likable' versions for each descriptor was taken as a safeguard against experimenter's effects or other invalidities that might emerge from use of one descriptor.
[70] In these studies, subjects were required to report preferences for use of descriptors over more or less likable alternatives as a description for themselves (Norman, 1967; and Saucier, 1997).
[71] Descriptor pairs can be identified by combining descriptors across the third and fourth columns of the table. Trait strength and likability can be distinguished in Table 2.1 by the level labels and the descriptors' vertical alignment with "+" and "-" symbols in the second column.

PEN MODEL TRAIT DESCRIPTORS			
***PEN* FACTOR**	**LEVEL & LIKABILITY**	**SIGNAL CHARACTERISTIC**	
		Creative	**Tough-Minded**
Psychoticism	+ High -	Very Creative Innovative	Tough-Minded Stubborn
	+ Moderate -	Original Creative	Reasonable Considerate
	+ Low -	Narrow Minded Unoriginal	Agreeable Submissive
		Sociable	**Assertive**
Extraversion	+ High -	Outgoing Very Forward	Demanding Dominant
	+ Moderate -	Sociable Approachable	Cooperative Assertive
	+ Low -	Shy Very Shy-	Accommodating Timid
		Anxious	**Emotional**
Neuroticism	+ High -	Nervous[72] Tense	Passionate Moody
	+ Moderate -	Sensitive Anxious	Moderately Stable Moderately Emotional
	+ Low -	Calm Very Relaxed	Stable Unemotional

Eighteen descriptor pairs were then identified by combining descriptors with the same likability rating from the two signal characteristics of each personality factor at each level.[73] This provided two descriptor pairs as the basis for factor representation at three levels for each factor according to the requirements imposed by the experimental design.

[72] Norman's (1967) study did not report relative likability for either term in this descriptor pair. These descriptors were arbitrarily assigned as 'more likable' and 'less likable' for the target trait.
[73] Once paired, neutral descriptors assumed the likability rating of its paired descriptor.

These 18 personality descriptor pairs were combined into seven ‘more likable’ and seven ‘less likable’ descriptor groups. As displayed in the Table B.1 of Appendix B, these were accepted for use in the development of word pictures to stimulate subjects’ evocation of coherent, generally complete and distinct personality trait variants.[74] They also provided for development of unique and efficient subject personality measures, which are discussed at Section 2.6.3 below.

2.5.2 Situational Factor Development, Descriptors and Groups

The attributes assigned as subfactors in Section 1.4.2.3 of Chapter 1 were assessed to sufficiently represent the dimensional aspects of a situation that have implications for *DxQual.* These were adopted as the signal characteristics for situational factors and the basis for organization of descriptors and descriptor groups representing factors at the levels required by the experimental design.[75] Descriptors were then selected from plain language to represent signal characteristics for *EnvStim* and *ProStruc* at low, moderate and high levels. Descriptors were selected for *SptGrp* only at low and high levels.[76]

As with the personality factors, descriptors for each signal characteristic were combined by strength level as descriptor groups, with each designated as the situational stimuli component for the specified level and factor. Table B.2 of Appendix B depicts the selected descriptors and descriptor groups for each of the situational factors.

[74] See Section 2.6.1 below.
[75] Signal characteristics for the situational factors were designed to reflect a practical maximum of decision-maker stimulation when established at a high setting and practical minimum of stimulation when at a low setting. Practical maximums and minimums were defined as the estimated limits for stimulation levels that might reasonably occur in the context of formally controlled decision-making events.
[76] The Study 1 experimental design precluded the use of more than two levels for any situational factor. In addition, preliminary planning for Study 2 indicated that there would be no need for a third level of *SptGrp* to support that research. However, moderate descriptors were required for use in the development of a composite scenario for Study 2. See Chapter 3, Section 3.1.1 for further discussion.

2.5.3 *Experimental Control Factor Development and Descriptors*

As discussed in Section 1.4.2.2 of Chapter 1, *Intelligence*, *Experience*, *Conscientiousness* and *Decision Typology* were also included as experimental factors for the purpose of clarifying potentially critical attributes of the decision makers and situations.[77] All were selected for inclusion because they have been well-documented to significantly affect individual judgment and/or behavior. In addition, it would not have been useful for subjects to make inferences about probable decision-making performance based upon individually different concepts – or the lack of them – for these attributes within their scenario-based percepts.

For *Intelligence, Experience* and *Conscientiousness,*[78] it was assessed that signal characteristics were not required to support their representation in the stimuli. As such, 'highly intelligent', 'experienced' and 'conscientious' were selected as the plain language descriptors for these factors. This reflected an assumption that organizations would not systematically place unintelligent, inexperienced and unconscientious persons in positions to make critical decisions on the organization's behalf. This selection also reflected this researcher's disinterest in examining the performance of unqualified decision makers.

[77] These four factors were not considered for manipulation, which clearly affected the generalizability of the study's findings. However, like the rationale for selection of the *PEN model* over the more-complex alternatives, we assessed that the multi-level treatment of any of these additional factors would complicate the experimental design unless more stringent limits were imposed on the articulation of the six core factors. Thus, the factors' inclusion at a single level was seen as a better solution than their exclusion altogether. The level selections for the factors were not arbitrary, and their inclusion at the selected level generally lent robustness to the descriptions of decision makers and decision-making circumstances.

[78] As detailed in Section 1.4.2.2 of Chapter 1, the inclusion of stimuli for high *Conscientiousness* introduced construct validity risks to the experimental representation of other personality factors as stimuli. The use of 'conscientious' as a descriptor was expected to affect subjects' evocation of whole person percepts with no means of accounting for which personality factors were or were not affected.

The effective representation of the 'problem' underlying the need for an organizational decision would require exposing subjects to numerous, potentially salient aspects of that problem. As such, the component attributes of *Decision Typology* identified in Section 1.4.2.3 of Chapter 1 were accepted as its signal characteristics. Plain language descriptors for each signal characteristic were selected at the high level to robustly represent an important and difficult problem. The descriptors assigned to these four invariant factors are shown at Table B.3 of Appendix B.

2.5.4 Non-experimental Factors / Concomitant Variables

Other factors required for post hoc analysis were derived from subject measures and other subject and survey classification data. Four factors were established to measure subject personality according to the *PEN model*'s super-factors and its associated *L-scale* (H. Eysenck, 1990, 1998; H. Eysenck & M. Eysenck, 1985). These included *SubjPsychFix* as a measure of subject psychoticism, *SubjExtravFix* as a measure of subject extraversion, and *SubjNeuroFix* as a measure of subject neuroticism.[79] As a measure against the *L-scale*, a subject dissimulation factor (*SubjLikBias*) was established to estimate the strength of subject preferences for describing themselves with more or less likable descriptors of the same estimated trait strength. Survey version number and subject factors for age, gender, vocation, relevant experience and subject pool were also planned for inclusion in the post hoc analysis as possible sources of random effects.

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[79] It was deemed impractical that experimental subjects be required to complete either the *EPP or the EPQ* during their study participation due to the extensive time this would add to their total engagement in the study. Acknowledging that formally established and validated personality measures would likely have strengthened the validity of the subject personality factors as covariates, the selected approach for measuring subject personality reduced participation time requirements by more than 50 percent.

2.6 Survey Stimuli and Item Development

In total, there were 56 experimental items and 43 non-experimental items developed for each of the four survey versions implemented by this study. The following sections describe the development of those items for inclusion in the survey instruments.

2.6.1 Experimental Stimuli

Given that subjects would be required for each of 56 separate scenarios to self-generate some sense of a viable person as decision maker and plausible decision-making circumstances, the efficient representation of the experimental scenarios by stimuli was expected to be a challenge. This presumed that subjects would be exposed to and internalize stimuli as a representation of all experimental factors, form and evaluate percepts for both the decision maker and the situation, and finally, deliver an assessment of the probable quality of a decision made in the scenario. Thus, the combined stimuli components needed to communicate descriptive and distinctive aspects of the experimental factors, with each factor effectively represented at the strength level dictated by the experimental design.

Once descriptors were grouped for each experimental factor as discussed in Section 2.5, they were further combined within six stimuli groups for inclusion in word pictures. These were established in combinations supporting each of the experimental scenarios with two run versions for each. Version A was composed of ‘more likable’ personality descriptors and Version B of ‘less likable’ descriptors for a total of 112 run versions.

The ‘Key Personal Attributes’ stimuli group was established as a graphic platform to sequentially display one of the seven personality descriptor groups for each experimental run. However, the ordering of personality descriptor groups within this stimuli group was rotated across experimental blocks and scenario versions to reduce the likelihood of ordering effects (Bordens & Abbott, 2011).

The ‘Decision-maker Attributes’ stimuli group contained the invariant descriptors for *Intelligence, Experience* and *Conscientiousness* as a supplement to the personality stimuli. The ‘Process Structure,’ ‘Environmental/Climate Strength,’ and ‘Decision-support Group’ stimuli groups were composed of the descriptor groups for each respective factor. The last stimuli group (‘Decision Typology’) was composed of the descriptors selected for the *Decision Typology* factor, which also remained invariant across all scenarios.

The ‘Decision-maker Attributes’, ‘Process Structure’, ‘Environmental/Climate Strength’, ‘Decision-support Group’ and ‘Decision Typology’ stimuli groups were further combined to produce the eight distinct situational and control factor combinations required by the experimental design. Descriptor ordering was rotated modestly within these groups to mitigate possible sequencing effects.

These were combined in the word pictures with the 14 distinct ‘Key Personal Attributes’ stimuli groups as treatment blocks. The relative placement of stimuli groups was the same for all word pictures to allow subjects to gain efficiencies in word picture processing by standardization. Graphic cues were included to guide subject processing of toward an effective assessment of probable decision quality for one treatment combination at a time.

The following figure depicts the word picture stimuli one run of the experiment.

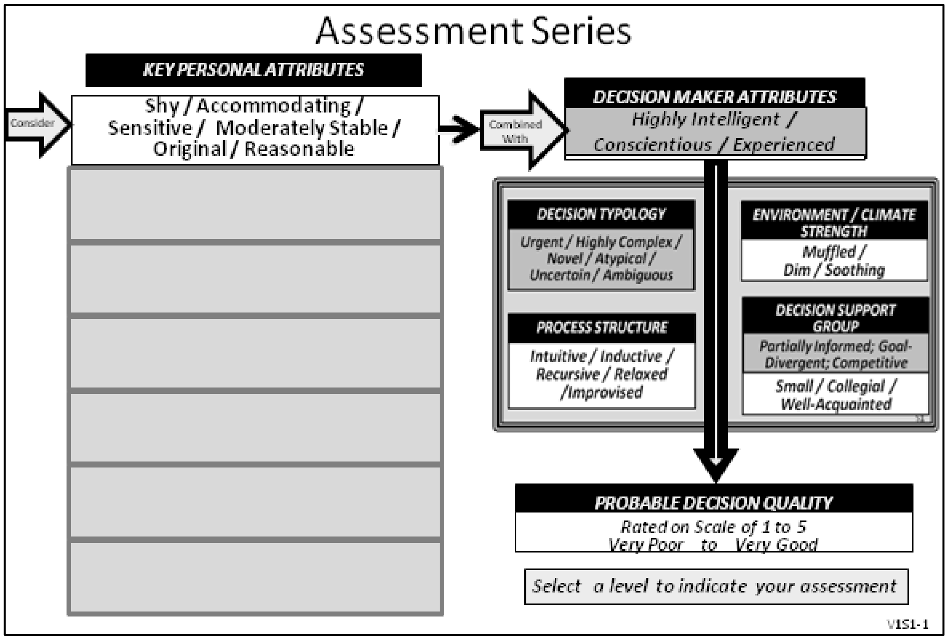

Figure 2.3: Study 1 Word Picture Stimuli

As illustrated above, six of the seven personality descriptor groups were masked for the presentation of stimuli for each experimental run. For the six subsequent runs included in the treatment block, the next personality stimuli group was unmasked and the previously completed group was masked/re-masked. All treatment blocks were prepared for presentation with the same sequenced unmasking/re-masking of personality stimuli groups.

The 56 stimuli composed of 'more likable' personality descriptors were then sequenced as Version A of the survey, with the remaining 56 stimuli sequenced as Version B. The order of treatment blocks within the versions were then counterbalanced by Latin Squares to produce a total of four survey versions (C. Wu & Hamada, 2009). Separate survey items were developed for use in eliciting subject assessments of *DxQual* for each of the experimental runs. These simply required subject responses on a five-point Likert scale from 1 for a 'Very Bad Decision' to 5 for a 'Very Good Decision'.

2.6.2 Control Policy Assessment Items

Eight survey items were developed to obtain subject assessments of the relative importance for placing controls over eight separate conditions that might be expected by subjects to impact on decision-making performance.[80] This aspect of the study was motivated by the *policy-capturing* technique (Aiman-Smith et al., 2002; Brehmer, 1988; Zedeck, 1977). The controls required for assessment included: 'Problem Typology'; 'Decision-making Process'; 'Environmental Conditions'; 'Participant Information Level'; 'Participant Goal Congruence'; 'Participant Conflict Potential'; 'Social Composition'; and 'Decision-maker State'.[81] These items were developed as plain text descriptions of the control policies followed by graphic prompts for the subject's assessment on a four-point Likert scale from 1 (Bad to Control) to 4 (Critical to Control).

2.6.3 Subject Measurement Items

Eighteen survey items were developed to support measurement of subject personality for use as random covariates in the analysis of the experimental results. These were designed to elicit the degree to which subjects saw themselves as effectively described by each of the 18 trait personality descriptor pairs[82] developed for use as personality fixed-factors (see Table B.1 at Appendix B). These items were prepared as presentations of the personality descriptor groups followed by graphic prompts for subjects to indicate their

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[80] Specific assessments were not requested for individual treatment combinations. Instead, control recommendations were requested only after subjects' completion of all 56 runs.

[81] Two controls were explicitly tied to situational factors (*EnvStim* and *ProStruc*). Four others were derived from the *Vroom-Yetton model* (Vroom & Jago, 1988). 'Decision Maker State' was included to gauge subject perspectives on the need for control over individual attributes of the designated decision maker.

[82] The use of 'more likable' and 'less likable' versions for each descriptor pair was expected to enhance the marginal validity of the study's subject personality measures by allowing estimation of each subject's three personality factors by six items instead of three. They also provided an expedient means to simultaneously measure subject dissimulation by analysis of their individual preferences for 'more' or 'less likable' pairs.

response on a five-point Likert scale ranging from 1 (Completely Inaccurate Description of Me) to 5 (Perfect Description of Me).

Eleven survey items were developed to obtain subject self-reports of knowledge of and experience with organizational decision making and/or related activities and concepts. These required subjects' responses on a three-point Likert scale ranging from 1 (low/limited/no knowledge or experience) to 3 (high/expert/extensive knowledge or experience). An additional six items were developed to obtain subject classification data for age, gender, vocation, relevant experience and whether they were currently enrolled as a student in an executive or professional education program. As with the subject personality, the measures obtained against these 17 items were anticipated for use as random covariates in the analysis of the experimental and *policy-capturing* results.

2.7 Study 1 Analysis

2.7.1 Survey Administration and Participants

An estimated 1,875 subjects were invited for participation by email. An unknown number of others were recruited coincidentally by forwarded email invitations. There were 271 total respondents with an estimated response rate of 14.45 percent.[83] The four survey versions were issued randomly by the Zoomerang platform as subjects accessed the survey website by email links. However, 44 respondents – or 16 percent - opted not to provide informed consent or complete initial subject classification items. An additional 111 respondents (41 percent) failed to complete all eight experimental blocks with the required concluding items. As such, the overall survey completion rate was 43 percent with 116

[83] Validated experimental data for Study 1 are available in the document entitled "Study 1 Response Data (Final)" included as a supplementary file to this report..

subject records.[84] Two of these records were invalidated due to invalid patterns of response across the 56 scenarios, leaving 114 records as valid for further analysis.[85] The four survey versions were comparably represented in the final tally of survey results, with 28 validated records each for versions 1A and 2B and 29 records each for versions 1B and 2A.

Twenty-two of these validated records were obtained from faculty, students and alumni of the U.S. Joint Forces Staff College and associated military education institutions. Sixteen were obtained from faculty, students, alumni and associates of the Georgia Institute of Technology Executive Master of Business Administration (GTEMBA) program. The remaining 76 validated subjects did not provide an optional response indicating their association with any educational program. Only the GTEMBA program participants received nominal compensation for their participation.[86] Of the 114 validated subjects, 101 were male, and 13 were female. Sixty-one percent were either active or retired military officers. The median and modal age was '40-49 years' with 70 subjects reporting in this category.[87] The median and modal response on experience with organizational decision making was greater than 20 years, with 63 subjects reporting in this category.[88] Subject

[84] Fatigue effects were in evidence by both the pattern of self-terminations and the changes in variance over the eight experimental blocks. Variance within the individual experimental items was dramatically higher for subjects who failed to complete all experimental blocks.

[85] Across the 114 validated records, 25 non-critical, non-experimental datum were identified as missing. All missing data related to non-mandatory survey items used to estimate subject personality and experience. Missing at random (MAR) and missing completely at random (MCAR) data were imputed as the mean response for the data element across the validated sample. Only six datum were identified as missing not at random (MNAR), which were related to subject personality measures. Values for these data elements were imputed from the same subject's assessment of the most closely related personality descriptor pair.

[86] Department of Defense professionals were prevented from receiving any compensation by military policy.

[87] Nine subjects reported being between 30 to 39 years of age, 70 reported being between 40 and 49, and 35 reported being between 50 to 59 years of age. No subjects reported their age as under 30 or over 60.

[88] One subject reported between 1 and 5 years, 15 reported between 5 and 10 years, 35 reported between 10 and 20 years and 63 reported greater than 20 years.

personality measures produced results that were generally as expected.[89]

Statistics for subject personality measures are provided in the following table.

Table 2.2: Study 1 Subject Personality Measures

SUBJECT PERSONALITY FACTOR	MEAN	VARIANCE	MIN VALUE	MAX VALUE
***Subject Psychoticism* (*SubjPsychFix*)**	0.559	0.346	-1.044	2.367
***Subject Extraversion* (*SubjExtravFix*)**	0.591	0.240	-0.700	1.800
***Subject Neuroticism* (*SubjNeuroFix*)**	-0.731	0.657	-4.000	1.100
***Subject Dissimulation* (*SubjLikBias*)**	0.008	0.025	-0.528	0.800

By visual inspection, these measures were found to be approximately normally distributed.

2.7.2 Decision Quality

The completion of 56 runs by each subject produced 6,384 experimental runs. *DxQual* was designated as the response variable. The six core experimental factors were established for analysis as independent variables with *Psych, Extrav* and *Neuro* included as the three fixed personality factors and *EnvStim*, *ProStruc* and *SptGrp* included as the three fixed situational factors. *Subject,* and *Version* were included as random effects.[90] And, while only three interaction effects were included in this study's formal hypotheses, a total of eight first-level factor interactions and three second-level interactions were included in the regression model to provide additional insight into the development of Study 2 objectives and hypotheses.[91] Invariant factors were not included.

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[89] Continuous measures for each of the three subject personality factors were determined by evaluation of subject responses to the six personality descriptor pairs required for assessment of each factor.

[90] Several concomitant factors were evaluated for their potential contribution to response variance. None of these proved to be significant in any of several model variations, and so they were excluded.

[91] The results of analysis for these non-hypothesized interactions are indicated in the lower half of the mixed model results at Table 2.3.

The mean response for *DxQual* was 3.427 with a variance of 0.84. Cronbach's alpha was evaluated at 0.98. The response data was analyzed in R as a linear mixed-effects model, applying the restricted maximum likelihood approach.[92] The following table depicts the fixed-factor effects reported by the mixed model analysis:

Table 2.3: Study 1 Mixed-model Fixed Effects[93]

Experimental Response: Decision Quality (DxQual) **Mixed Model Regression Results (Fixed-factors Only)**						
Fixed Effects	**Estimate**	**Std Error**	**t Value**	**p Value**	**Significance** *** : p < 0.25** **** : p < 0.10** ***** : p < 0.05**	**Remarks**
(Intercept)	0.427	0.040	10.724	0.000	***	
Psych	0.276	0.017	15.874	0.000	***	H_P Supported
Extrav	0.427	0.017	24.553	0.000	***	H_E Supported
Neuro	-0.536	0.017	-30.864	0.000	***	H_N Supported
EnvStim	0.066	0.009	7.136	0.000	***	H_C Supported
ProStruc	-0.009	0.009	-0.928	0.354		Implicated by H_{PXS}
SptGrp	0.064	0.009	6.899	0.000	***	H_G Supported
Psych:ProStruc	0.043	0.017	2.493	0.013	***	H_{PXS} Supported
Extrav:SptGrp	-0.101	0.017	-5.807	0.000	***	H_{EXG} Supported
Neuro:EnvStim	0.015	0.017	0.884	0.377		Fail to reject H_0
Additional Interactions – Not hypothesized in advance						
Neuro:SptGrp	0.008	0.017	0.442	0.659		
Extrav:EnvStim	-0.054	0.017	-3.093	0.002	***	
EnvStim:SptGrp	0.001	0.009	0.118	0.906		
Psych:SptGrp	-0.010	0.017	-0.600	0.549		
Psych:EnvStim	0.003	0.017	0.158	0.875		
Extrav:EnvStim:SptGrp	-0.035	0.017	-2.020	0.043	***	
Neuro:EnvStim:SptGrp	-0.013	0.017	-0.757	0.449		
Psych:EnvStim:SptGrp	-0.001	0.017	-0.032	0.975		

[92] Various efforts were made to transform predictors and the response with limited improvements to model fit. Variable transformations were ultimately rejected due to the known limitations of the experimental design and the uncertain calibration for the scaled personality factors.
[93] The complete results are available at Appendix B.

These results provided direct support for the inclusion of five core factors in the model by their reported main effects. Support for inclusion of the sixth factor (*ProStruc*) was obtained by the indicated statistical significance of the *Psych:ProStruc* interaction. However, it was also notable that the practical significance of the three situational factors was low as compared to the personality factors. The marginal R-squared was evaluated at 0.200 with a conditional R-squared of 0.350.[94] The residual standard error was evaluated at 0.550. Given the structural error imposed by use of the Likert scale for the experimental response, and the expected noisiness of the mental simulations employed as experimental runs, this indicated an acceptable model fit.

The response data were then reevaluated with a revised mixed model that combined the three situational factors as a single *SitStim* factor. This was undertaken in multiple model configurations to determine if a single, multidimensional situational factor could be substituted in *WREM* for its three situational factors to reduce experimental run requirements for Study 2. All three personality factors and the *SitStim* factor indicated highly significant main effects p-values < 0.001. However, none of the factor interactions (*SitStim:Psych*, *SitStim:Extrav* and *SitStim:Neuro)* reached statistical or practical significance. As such, these results provided no support for inference of *Situational Strength* effects (Meyer, et al., 2009; Meyer & Dalal, 2009; Meyer, Kelly & Bowling, 2017). It was tentatively concluded that *SitStim* was not a suitable proxy for *WREM's* situational factors.

[94] For generalized linear mixed models, marginal R-squared measures variance attributable to fixed-factors while conditional R-squared measures variance attributable to both fixed and random factors and excluding residual variance (Nakagawa & Schielzeth, 2013).

2.7.3 Control Policy Assessments

As stated previously, eight survey items elicited subject assessments of the criticality for control over selected conditions and decision-maker attributes. These assessments were required on a scale from 1 (Bad to Control) to 4 (Critical to Control). The results of those assessments were as indicated in the following table:

Table 2.4: Study 1 Control Policy Assessments

Control Policy	Mean	Variance
Decision Typology	2.82	0.59
Decision-making Process	3.21	0.57
Environmental Stimulation	2.54	0.39
Participant Information	2.59	0.56
Participant Goal Congruence	2.67	0.74
Participant Conflict	2.42	0.58
Social Composition	2.80	0.53
Decision-maker State	3.40	0.50

All eight control options were assessed as relatively important by a plurality of subjects, with controls over the 'decision-making process' and 'decision-maker state' indicated as especially critical. However, no statistical significance could be assigned to any of the mean assessments given the relatively large variance indicated for each. It was thus accepted that such control policies would have been better examined within the individual experimental scenarios as opposed to across them.

2.8 Discussion and Summary

2.8.1 Findings

As reported in Table 2.3, the experimental results of Study 1 directly supported the acceptance of five of the six core factors as statistically significant at a $p < 0.001$. In addition, all three personality factors indicated relatively high practical significance.

However, the absence of a significant main effect for *ProStruc* and the much lower effect sizes for the situational variables were much less reassuring.

It was considered that the disparity between effect sizes of the personality and situational factors might have been expected based upon the lesser coverage of the experimental design space for the situational factors (2 design points each) as compared to the personality factors (3 design points each). In addition, this outcome might have been facilitated by the greater emphasis or prominence of the personality factors within the stimuli, and/or to greater accessibility within subjects of decision-maker percepts as compared to situational percepts. Nonetheless, it was accepted that if similarly anemic situational effects were produced through further experimentation, it must also be considered that the situational factors are not adequately represented by the stimuli.

Beyond the main effects, only one of the three hypothesized factor interactions met the $p < 0.25$ H_0 rejection threshold where *Psych:ProStruc* indicated an interaction effect with $p < 0.001$. This result was vital to establishing rationale for the continued inclusion of *ProStruc* as a core factor in *WREM*. Three of the eight un-hypothesized interactions further implicated all other predictor variables, further clarifying their critical roles in the mixed model hierarchy. The result for the second-level (three-way) interaction (*Extrav:EnvStim:SptGrp*) was useful for informing the development of the research objectives and hypotheses for Study 2.

Thus, the analytic results directly supported rejection of the null hypothesis in lieu of hypotheses H_P, H_E, H_N, H_C, H_G and H_{PXS}. The results also indirectly supported the rejection of the null hypothesis in lieu of H_S and H_{PXS} by implication from the significant

Psych:ProStruc and the *Extrav:EnvStim:SptGrp* interactions. This led to the non-acceptance of H_{NXC} that predicted a non-zero interaction effects for *Neuro:EnvStim.*

2.8.2 Study Limitations

The primary limitation of this study arose from the representation of the decision-making events as *thought experiments,*[95] where each run depended upon the subject's independent mental simulation of the events targeted for assessment. As such, there was no objective basis for any of the 6,384 experimental runs. Nonetheless, it was accepted that more objective or realistic event representation would have imposed time-based limitations on run-size, unjustifiable costs or both. With all its inherent limitations, this experiment by survey neatly suited the immediate requirements of this research

The use of complex, text-based stimuli to support the experimental runs was and remains an important concern. Subject cognitive workload for each experimental run was very likely stretched to practical human performance limits predicted by *Miller's law* (Miller, 1956). In fact, it was suspected that high cognitive workload may have contributed to the lower effect sizes for situational factors as they were each presented less prominently than the decision-maker attributes within the word pictures. It was thus determined that, if similar stimuli were to be employed in future experimentation, increased consideration for stimuli randomization and/or reinforcement would be appropriate.

The inability to examine for curvilinear relationships between situational factors and the experimental response was a regrettable constraint imposed by the experimental design. As such, it was concluded that an increase in situational factor design points would

[95] See footnote 43.

be required in any follow-on examinations to permit testing for patterns of situational factor effects that might be predicted by the *Yerkes-Dodson law* (Wickens & Holland, 2000). In fact, it was tentatively concluded that all predictor variables warranted close consideration for their possible curvilinear relations with the response when they could be reexamined with a less sparse distribution across their theoretic factor ranges.

The study sample itself presents challenges related to the generalizability of the results. Despite the enormous value of the average subject's time commitment to this research, subject age, gender, military affiliation, level of education and experience set the sample apart from the likely norms of the greater decision-making population. Beyond this, the 57 percent non-completion rate also suggests questions about possible correlations between subject completion and subject individual differences. Clearly, a more diverse and balanced sample would be preferred to validate the parametric model intended for delivery by this body of research.

2.8.3 Study 1 Conclusions

The general hypothesis of this study was confirmed. According to the judgment of this study's subjects, specific situational factors do variably affect decision quality according to the personality of a designated decision maker. Notwithstanding the predominance of personality factor effects, the six core experimental factors established a sound theoretical basis for *WREM*.

Five of the six hypotheses related to core factor effects were strongly supported by the results, with the sixth hypothesis (H_S) hierarchically implicated by a first-level interaction (H_{PXS}). However, because of the relatively low practical significance of the situational factors and the concerns previously noted about their prominence within the stimuli, all hypotheses related to the first-level factor interactions were set aside for re-investigation under an adjusted experimental approach in Study 2.

The selection of the *PEN model* and its representation by the word picture stimuli and subject measures was both appropriate and sufficient for the purposes of this experiment. The *PEN model*'s comparative simplicity allowed for a unique and efficient experimental design, manageably succinct personality stimuli, and effective subject personality measures derived from the nine *trait dimensional scales*.[96]

In conclusion, this study set the necessary conditions to consider further testing and refinement of *WREM* as a model for optimizing decision quality according to the personality of decision makers. Confirmation of the indicated factor interactions was set as the objective of the next study.

[96] The subject personality self-assessments provided validation of the *trait dimensional scales* for use in this experimental context, while also providing useful insights for adjusting the scale origins and range. In addition, the personality factor representations derived from the *trait dimensional scales* were conclusively impactful on the assessments of *Decision Quality* (*DxQual*).

CHAPTER 3. INTERACTION EFFECTS IN DECISION MAKING (STUDY 2)

3.1 Introduction

As the second of two experimental studies, Study 2 verified the significance of key personality and situational factor interactions affecting organizationally supported decision making. Based on their demonstrated significance in Study 1, the core factors themselves were accepted as the independent variables for the further examination of decision making performance in the context of the *War Room Effects Model* (*WREM*). As described in Section 1.2 of Chapter 1, *WREM* is a parametric model of organizationally supported decision making that permits optimization of decision quality through the adaptive control of situational conditions linked to the personality characteristics of decision makers.

This study tested hypotheses related to factor interactions between *WREM*'s component variables. The results generally demonstrated that situational conditions do variably affect cognitive performance according to the personality of the designated decision maker. In addition, the further evaluation of these variables permitted the establishment of the parametric model required for the development of situational control options that would support the optimization of decision quality.

This study was completed as an online survey[97] through the concurrent implementation of an experiment and a *policy-capturing*[98] exercise. For the experimental

[97] A copy of the survey entitled "Personality and Situational Effects in Decision Making" is included as a supplementary file to this report.
[98] See footnote 55.

components of the survey, respondents were required to assess the probable quality of decisions made in a semi-randomized series of decision-making events. For the *policy-capturing* components, respondents were required to provide recommendations for or against the implementation of situational controls over selected conditions as might have supported better decision making.

The decision-making events required for assessment were established by induction and mental simulation of decision-making scenarios.[99] After presentation of each scenario's stimuli, subjects were prompted to assess probable decision quality as the experimental response. Subjects were then required to provide their assessment of the need for adjustment to three distinct situational conditions that might support improved decision making within the established scenario. Each subject repeated these decision quality and control policy assessments for between 3 and 13 experimental runs depending on their individual preference to continue.

Twenty-seven participants completed the survey with a total of 22 subject records and 182 experimental runs accepted as valid.[100] Post hoc evaluation of the experimental response data confirmed the significance of eight factor interactions related to the study's hypotheses. In addition, main effects for three of *WREM*'s independent variables were indicated as significant by the *policy-capturing* results, with two others hierarchically implicated by factor interactions in either the experimental or *policy-capturing* response data. However, in contrast to the results from Study 1, *Neuroticism* was not indicated as

[99] See footnote 43.
[100] Additional recruitment, response and data validation details are provided Section 0 of this chapter.

significant by any aspect of this study.

The practical significance of experimental effects was found to be heavily weighted in the interactions. This specific aspect of the results provided importantly nuanced insights for the refinement and conditional validation of *WREM* and for the development of situational control options that would facilitate improved decision making.

3.2 Study 2 Factor Definitions

The factors selected for examination in this study were the same as those employed in Study 1. *Decision Quality* was designated as the experimental response as a proxy for the *Decision Effectiveness* variable of *WREM*. *Psychoticism*, *Extraversion* and *Neuroticism* were designated as the independent variables representing decision maker personality. *Environmental Stimulation*, *Process Structure*, and *Support Group* were designated to represent situational conditions.

As other key attributes of the scenario-based decision makers and circumstances, *Intelligence*, *Experience*, *Conscientiousness* and *Decision Typology* were designated as experimental control factors. Following are the definitions applied to the factors in both the experimental and *policy-capturing* components of the survey, which represent minor adaptations to the definitions for the same factors as applied to Study 1 (see Chapter 2, Sections 2.2 and 2.5.1).

- <u>*Dependent Variable:*</u> *Decision Quality (DxQual*) – The subject's assessment of the probable quality for a decision made at the culmination of a decision-making event without regard for its implementation.[101] This dependent variable was collected on a Likert scale as the subject response to experimental stimuli.

[101] This variable is also referred to in *WREM* as *Cognitive Performance*.

- *Independent Variables*

- *Personality Factors:*[102] These factors were established by two methods. The first was through use of stimuli representing the factors at the strength levels required by the fixed-factor experimental design. The second was through the imputation of subject personality measures as random-imputed-as-fixed (hybrid) factors.

    - *Psychoticism* (*Psych*) – The measured or represented level of the decision maker's tendency for aggression and for having (or not having) psychotic episodes or breaks with reality. C*reative* and *tough-minded* were assigned as subfactors to support representation of *Psych*.

    - *Extraversion* (*Extrav*) – The measured or represented level of the decision maker's tendency for positive affectivity and for social and external engagement. *Sociable* and *assertive* were assigned as subfactors to support representation of *Extrav*.

    - *Neuroticism* (*Neuro*) – The measured or represented level of the decision maker's tendency for emotionality or negative affectivity. *Anxious* and *emotional* were assigned as subfactors to support representation of *Neuro*.

- *Other Decision Maker Attributes as Factors:* These were established by stimuli representing factors at the strength levels required by the experimental design.

    - *Intelligence* – The represented level of a decision maker's mental abilities. This was developed for use as a control factor and set at high for this study.

    - *Experience* – The represented level of the decision maker's task-relevant experience. This was developed for use as a control factor and set at high for this study.

    - *Conscientiousness*[103] – The represented level of a decision maker's positive intentions as demonstrated by responsible behavior. This was developed for use as a control factor and set at high level for this study.

- *Situational Factors:* These were established through use of stimuli representing the factors at the strength levels required by the experimental design.[104]

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[102] As discussed in Section 2.2 of Chapter 2, these definitions were adapted for use in experimentation from the super-factor definitions of the *PEN model*'s (H. Eysenck, 1998; H. Eysenck & M. Eysenck,1985).
[103] See footnote 36.
[104] As discussed in Chapter 1, Section 1.4.2.3, attributes were previously assigned as subfactors to *WREM's* situational factors to support their effective representation during experimentation.

- *Environmental Stimulation (EnvStim)* – The represented level of sensory stimulation produced by environmental and physical sources within a decision-making event. The three subfactors assigned to support representation of *EnvStim* were *auditory*, *visual*, and *haptic/other* stimulation.

- *Support Group (SptGrp)* – The represented level of interpersonal and interactive stimulation produced by a social group established to support a decision-making event. The four subfactors assigned to support representation of *SptGrp* were *subordinate information, goal congruence, subordinate conflict* and *social composition.*

- *Process Structure (ProStruc)*– The measured or represented level of stimulation produced by the deliberative approach or problem-solving method imposed on a decision-making event. The three subfactors assigned to support representation of *ProStruc* were *logic*, *rigor* and *clarity*.

- *Decision Typology* – The represented categorization of decisions according to characteristics of the problem requiring a decision. This was developed for use as a control factor. The five subfactors assigned to support representation of *Decision Typology* were *urgency*, *complexity*, *novelty*/*typicality*, *criticality* and *uncertainty/ambiguity*. All subfactors were set to represent the factor at a high level.

These experimental factors were further developed to support their use in the experimental stimuli as discussed later in this chapter at Section 3.5.

Three non-experimental factors were established as refinements to the control policy assessments from Study 1.[105] These were collected for each run as subject recommendations for adjustment to situational conditions. These *policy-capturing* response variables included:

- *Environmental Stimulation Level* (*EnvStimLvl*): The subject's assessment of the need to modify the noise, light and other physical stimulation levels to improve decision making performance.

[105] For Study 1, subjects were required to evaluate the criticality of eight policy controls only one once after completing all 56 experimental runs. See Chapter 2, Section 2.6.3 for further details.

- *Process Structure Stimulation Level* (*ProcStimLvl*): The subject's assessment of the need to modify decision-making process constraints, structure and clarity to improve decision making performance.

- *Support Group Stimulation Level* (*GrpStimLvl*): The subject's assessment of the need to modify aspects of the decision-support group to improve decision making performance.

Other factors required for post hoc analysis were derived from subject measures and other survey items. These included the four subject personality measures required for imputation as personality factors, subject classification factors and survey/scenario classification factors. These are each addressed in detail in Section 3.6.1.1 to this chapter.

3.3 Study Hypotheses

The objective of this study was to generally confirm and build-upon the findings of Study 1. Because of improvements made to the experimental stimuli and changes to the experimental design from those applied to Study 1, the hypotheses for this study focused on the examination of key *interaction effects* between personality and situational factors. If confirmed as significant, these interactions would support acceptance of a conclusion that decision makers make better decisions when the supporting conditions are aligned to their personalities. Beyond this, the study was undertaken with a view toward establishing the parametric model required to support personality-based optimization.

As previously indicated, the main effects for all six core factors were strongly confirmed by Study 1's results. It was not expected that this study would replicate these results due to changes in the experimental approach and the inclusion of additional interactions in the regression models used for analysis. As such, the six hypotheses of Study 1 related to the main effects were planned for post hoc evaluation but were not included among this study's formal hypotheses. However, it was anticipated that the examination of the main effects of *WREM*'s independent variables would provide new insights about their possible curvilinear relationships with *DxQual* consistent with the *Yerkes-Dodson law* (Wickens & Holland, 2000).[106]

The factor interactions were seen as fundamental to the refinement of *WREM* and the development of its practical applications. It was fully expected that the weight of these interactions would be demonstrated as a dominant aspect of the expected *War Room Effects.* As such, three hypotheses were adopted directly from Study 1 related to first-level factor interactions. Eight additional hypotheses were added to these, including five additional first-level factor interactions and three second-level interactions. Since it was not strongly indicated by the Study 1 results that any of the interactions would facilitate versus interfere with *DxQual,* these hypotheses were developed as predictions of non-zero interaction effects on the experimental response variable.

The 11 formal hypotheses were as follows:

- H_{PXS} : The *Psych:ProStruc* interaction will have non-zero effects on *DxQual.*
- H_{EXG} : The *Extrav:SptGrp* interaction will have non-zero effects on *DxQual.*
- H_{NXC} : The *Neuro:EnvStim* interaction will have non-zero effects on *DxQual.*
- H_{PXG} : The *Psych:SptGrp* interaction will have non-zero effects on *DxQual.*
- H_{PXC} : The *Psych:EnvStim* interaction will have non-zero effects on *DxQual.*
- H_{EXC} : The *Extrav:EnvStim* interaction will have non-zero effects on *DxQual.*
- H_{NXG} : The *Neuro:SptGrp* interaction will have non-zero effects on *DxQual.*
- H_{CXG} : The *EnvStim:SptGrp* interaction will have non-zero effects on *DxQual.*
- H_{EXCXG} : The *Extrav:EnvStim:SptGrp* interaction will have non-zero effects on *DxQual.*

[106] See footnote 55.

- H_{NXCXG} : The *Neuro:EnvStim:SptGrp* interaction will have non-zero effects on *DxQual.*
- H_{PXCXG} : The *Psych:EnvStim:SptGrp* interaction will have non-zero effects on *DxQual.*

Given the large number of interactions already included for formal examination, others were not identified in advance for evaluation.

Significant random effects were also expected to be revealed by the interaction of subject personality measures and the experimental factors and between subject personality measures and the subject's situational control policy recommendations. These interactions were expected to inform both the selection and refinement of regression models used in post hoc analysis and to support the development and refinement of the situational control options for *WREM*. More specifically, subjects' measured personality differences were expected to predict variable preferences for control over:

- The characteristics of the decision-making process (*ProStruc*) based upon the subject's measured level of psychoticism (*SubjPsychFix*).
- The characteristics of the decision-support group (*SptGrp*) based upon the subject's measured level of extraversion *(SubjExtravFix)*.
- The physical characteristics of the environment (*EnvStim*) and the decision-support group (*SptGrp*) based upon the subject's measured level of neuroticism (*SubjNeuroFix*).

In essence, subjects were expected to demonstrate personality-based biases for control that were different from the sample-wide recommendations.

Because this investigation was intended to provide refinements to *WREM* as a parametric model and establish justification for its further testing, the significance level for rejection of the null hypotheses was set at $p < 0.05$ for main effects, $p < 0.10$ for first-level interactions and $p < 0.25$ for second and third-level interactions. These relaxed acceptance thresholds were seen as necessary to preserve the conceptual integrity of *WREM* until it could be tested under more realistic conditions.

3.4 Study Methodology

3.4.1 Survey Description

As presented in the introduction to this chapter, this study was conducted by concurrently implementing two separate research techniques in the form of a single online survey.[107] The first technique was a repeated-measures, stimuli-response experiment, which solicited subject assessments of probable decision quality. To support these assessments, decision-making events were established by induction through use of scenario narratives and word pictures as stimuli as an adaptation of the *thought experimentation* technique.[108] These stimuli were composed of descriptive components representing each factor in the treatment combinations required for assessment and response.

The second research technique was an implementation of the *policy-capturing* method (Karren & Barringer, 2002; Cooksey, 1996; Brehmer, 1988; and Zedeck, 1977), which solicited subject recommendations for situational adjustments based upon the assessed suitability of the conditions represented by the scenario stimuli. These two techniques were combined in sequence for between three and 13 runs per subject,

[107] This survey was administered through the commercial services of SurveyMonkey. The study was approved for experimentation with human subjects by the Georgia Institute of Technology Institutional Review Board in January 2018. It was further validated by scientific review for implementation with U.S. Department of Defense personnel in July 2018.
[108] See footnote 55.

depending upon each subject's preference to extend their participation to additional scenarios beyond the mandatory minimum of two.

Decision-making events were induced by presentation of distinct stimuli for each of the seven scenarios. The first scenario was designed to support a single experimental run as a generic or normative decision making situation, with all fixed-factors set at their estimated norm and personality factors imputed from subject personality measures.[109] This scenario provided subjects a rehearsal of the survey procedures to be employed across all subsequent scenarios and runs. In addition, its results were intended to establish a baseline of response data. The remaining six scenarios were derived from historically based war-time decisions. These were composed to support two distinct experimental runs each, with the first implemented as a fixed-factor run and the second as a random/fixed-factor (hybrid) run with subject personality measures imputed for decision maker personality factors.

Immediately after subjects were provided the opportunity to consider the stimuli for each scenario and run, they were then required to perform their assessment of probable decision quality on a five-point Likert scale from 1 (Very Bad Decision) to 5 (Very Good Decision). Following this, subjects were required to provide their recommendations for or against adjustment of three situational conditions. Each of the recommendations related to

[109] Unique risks to the construct validity of the *Intelligence*, *Experience* and *Conscientiousness* control factors arose from the requirement for subjects to substitute themselves for the scenario-based decision maker for the hybrid run of each scenario. Since there was no mechanism for control over how subjects performed their mental role substitutions, it could not be known whether subjects would evoke and envisage these personal attributes – or even their own personality – with any specificity or validity. Nonetheless, subjects' self-appraisals were expected to sufficiently account for their own intelligence, experience and conscientiousness. As such, it was expected that subject percepts related to their self-appraisals would deviate across scenarios and subjects, with possible implications for unverifiable effects. Recognition of this risk reinforced the need to examine the consistency of response data between the fixed-factor runs and the random/fixed-factors runs, and to maintain a willingness to treat these data separately if inconsistencies were revealed.

the level of stimulation perceived by subjects as arising from the conditions represented by the stimuli. Subject options for completing these control policy assessments were to recommend for increasing, decreasing or making no adjustment to the respective situational conditions.

The single experimental run of the first scenario was a hybrid run where subjects were instructed to assess the decision-making event after considering themselves as the decision maker. This was expected to cause subjects to project their self-appraised personal attributes as the decision maker's person-related factors. The run was initiated by presentation of a word picture designed to stimulate a subject response and to support their performance of the control policy assessments. Upon completion of the first scenario, subjects advanced to the six scenarios that formed the experimental core of the survey.[110]

These six core scenarios were presented in a randomized sequence by subject. Unlike the first scenario, these were initiated by presentation of a narrative to afford subjects greater appreciation for the context and problem-related content of the induced/stimulated event. At the conclusion of the narratives, subjects were instructed to assume a role within the scenario, with responsibility to recommend adjustments to the decision making conditions. These were followed by word pictures designed as reinforcement of the scenario narratives.

After consideration of both stimuli components, subjects were required to perform their assessments of *DxQual* and the three control policy assessments. Upon completion of this fixed-factor run, subjects were prompted to initiate the hybrid run for the same

[110] Scenario 0 was presented first to all subjects and was not supported by a scenario narrative.

scenario. For these, subjects were instructed to re-assess the same event after considering themselves as substituted for the previously represented decision maker. Similar to the first scenario/run, this was expected to cause subjects to substitute their self-appraised personal attributes for the preceding run's person-related factors. No additional stimuli were provided, although subjects retained access to the scenario word picture from the preceding run. After consideration of the instructions to conduct this mental role-substitution, subjects were then required to perform their assessments of probable decision quality and the three control policies.

Following completion of the second run in each of the six primary scenarios, subjects were presented with a short historical summary of the events that served as the basis for development of the scenario. This pattern of stimuli presentation–assessment–role substitution–assessment–summary was repeated for up to five additional scenarios.

As a conclusion to their participation in the survey, subjects were finally required to complete an 18-item personality measure and a six item experience and expert knowledge measure. In total, there were a total 13 experimental items, 39 *policy-capturing* items, 18 subject personality measurement items and 12 other non-experimental items included in the survey. It was designed to take an estimated minimum of 15 minutes and a maximum of 60 minutes for completion. Subject options for partial completion extended only to their option to accept or decline participation in additional scenarios after completing the minimum required scenarios and runs.

3.4.2 Experimental Design

The six core experimental factors were established as independent variables in an unbalanced experimental design, uniquely hybridized to accommodate for combinations of fixed and random factors. Situational factor levels for the first scenario (Scenario 0) and its single run were set at the estimated norms (0) as a control setting for these factors. The personality factors for this run were imputed from each subject's three personality measures. Situational factor levels for Scenarios 1 through 6 and their included run-pairs were set at levels determined by analysis of the facts of the decision making cases used as the historical sources of the scenarios. The personality factors for the fixed-factor run of these six core scenarios were likewise set at the strength levels determined by analysis of each case's referent decision maker.[111] However, for the second run, personality factors were imputed from subject personality measures just as with the baseline scenario, while the situational factors remained the same as in the preceding run.

The maximum range of examination for the fixed-factors was from -1 (low strength) to 1 (high strength). However, the fixed-factor levels established for *Psych* and *EnvStim* did not span this entire interval. In the end, the full range of examination for the three personality factors was actually determined by the range of subject personality measures imputed as fixed-factors.[112] The range of examination for situational factors was not affected by imputation of any random factors.

The following table depicts the experimental design matrix for Study 2.[113]

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[111] See Section 3.1.1.1 below and Appendix C for discussion of the personality and situational factor settings for these scenarios.

[112] The examined range for personality factors was: *Psych* on the interval (-0.903, 1.505); *Extrav* on the interval (-1.292, 1.880); and *Neuro* on the interval (-2.668, 1.048).

[113] The random effects design matrix (or (Z matrix) is required to determine how treatment combinations were applied across experimental runs based on the inclusion of random factors. In this case, random factors included: 1) the random number of scenarios selected for completion by each subject; 2) the

Table 3.1: Study 2 Experimental Factor Settings[114]

Scenario \ Factor	*Psychoticism (Psych)*	*Extraversion (Extrav)*	*Neuroticism (Neuro)*	*Environmental Stimulation (EnvStim)*	*Process Structure (ProStruc)*	*Support Group (SptGrp)*
Scenario 0 (Baseline)	Imputed Random	Imputed Random	Imputed Random	0.000	0.000	0.000
Scenario 1 Run 1	1.000	-1.000	1.000	-0.333	1.000	-0.500
Scenario 1 Run 2	Imputed Random	Imputed Random	Imputed Random	-0.333	1.000	-0.500
Scenario 2 Run 1	0.000	0.000	0.000	-0.333	0.000	1.000
Scenario 2 Run 2	Imputed Random	Imputed Random	Imputed Random	-0.333	0.000	1.000
Scenario 3 Run 1	0.000	0.500	-0.500	-0.333	0.000	-0.500
Scenario 3 Run 2	Imputed Random	Imputed Random	Imputed Random	-0.333	0.000	-0.500
Scenario 4 Run 1	1.000	0.500	0.500	0.000	1.000	-1.000
Scenario 4 Run 2	Imputed Random	Imputed Random	Imputed Random	0.000	1.000	-1.000
Scenario 5 Run 1	1.000	1.000	-1.000	1.000	-1.000	1.000
Scenario 5 Run 2	Imputed Random	Imputed Random	Imputed Random	1.000	-1.000	1.000
Scenario 6 Run 1	0.000	0.000	-0.500	-0.667	-1.000	0.000
Scenario 6 Run 2	Imputed Random	Imputed Random	Imputed Random	-0.667	-1.000	0.000

These settings provided for the imbalanced examination of between two and five factor levels for each predictor variable, with the combinations examined at six distinct fixed-factor design points. However, additional hybrid design points resulted from the imputation of subject personality measures as experimental factors.

It was known that the imbalances in the fixed-factor experimental design would

randomized order of experimental scenarios; and 3) subject personality measures imputed for fixed personality factors. This Z matrix can be generated in R by the modelling code entitled “Study 2 Analysis R Code (Final)” included as a supplementary file to this report.

[114] Levels for experimental factors are -1 for low, 0 for moderate and 1 for high strength. For fixed-factors these were all on the interval (-1, 1). For personality factors imputed from subject measures, these were established on the interval (-4, 4).

create limitations on inferences related to uncovered gaps and poorly covered ranges for selected factors. However, after assuming a reasonable distribution of subject personality for imputation as fixed-factors in the hybrid runs, it was anticipated that there would be sufficient design points to support examination across the six-dimensional design space. It was also anticipated that the resulting design would be sufficient to obtain evidence of the curvilinearity between all factors and the experimental response. As such, the design limitations were deemed acceptable, especially given the unique nature of the experimental method and the objectives of this study. The resulting random effects design supported examination for 108 treatment combinations, six of which were established by fixed-factors and 102 more generated through implementation of the study by the imputation of subject measures.[115] However, the resulting experimental design was imbalanced, with relatively sparse coverage of low *Psych* and high *EnvStim*.

3.4.3 Subjects

A stochastic simulation was used to estimate study recruitment requirements.[116] This indicated the need for a sample size of 1,320 subjects. This was accepted as a goal, with an intent to suspend recruitment when the actual data were sufficient to support the effective examination of the study hypotheses. Survey recruitment was primarily directed toward individuals who, through either practice or professional education, were expected

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[115] The six fixed combinations of personality factors were derived from the analysis decision makers identified in the history of the American military experience at war. The 102 hybrid design points were developed by imputation of each subject's personality measures as the personality fixed-factors for hybrid experimental runs.

[116] This simulation applied residual variance and subject personality distribution parameters taken from the results of Study 1 and effects coefficients and runs-per-subject taken from the results of pilot testing for Study 2. The simulation was developed in R with fifty simulations of 660 simulated subjects for each. Across simulations, 25 percent of the 11 hypothesized factor interactions indicated statistical significance at $p < 0.10$. Assuming a 50 percent survey completion rate, this indicated the requirement for 1,320 total participants to obtain the statistical power required to effectively examine this study's hypotheses.

to have prior exposure to formal, organizationally supported decision-making processes.

As a secondary priority, career business professionals, academic faculty, researchers and graduate students were also recruited to improve the general applicability of the study. Inclusion criteria required that subjects be greater than 27 years of age, and that they have 5 or more years of military, government, business or professional academic experience. However, there were no criteria for exclusion of other participants in this study except that no subjects could be accepted for participation while they were present within the European Union at the time of their participation. [117] The results of the recruitment are discussed in Section 3.6.1 below.

3.5 Scenario Stimuli and Other Survey Items

The stimuli components for each of the seven experimental scenarios were developed using combinations of lexical descriptors and descriptor groups representing factors at the settings dictated by the experimental design. The following sections describe the development of the experimental scenarios, their stimuli components and other survey items used for collection of subject data.

3.5.1 Decision-making Cases and Scenarios

As the core of the experiment, seven decision-making scenarios were derived from the U.S. military's experience with decision making at war. Cases 1 through 5 would be recognizable to students of military history. These were:

- **Case 1 –** General Robert E. Lee's 2 July decision to order a general assault on Union forces to occur on 3 July 1863 (Coddington, 1968; Dowdey, 1965).

[117] European Union (EU) Human Protections policy requires the completion of EU consent protocols by human subjects located within the EU nations These protocols were not established for this study.

- **Case 2 –** General George G. Meade’s 2 July decision to order Union forces to maintain their defense against a Confederate assault to occur on 3 July 1863 (Coddington, 1968; Gibbon, 1888; Cleaves, 1991).

- **Case 3 –** General Dwight D. Eisenhower’s 5 June decision to order the Allied invasion of Normandy to occur on 6 June 1944 (Smith, 2012; Ambrose, 2016).

- **Case 4 –** General George S. Patton’s 19 December decision to attack to relieve besieged Allied forces in Bastogne to occur between 20 and 27 December 1944 (Blumenson, 1974; D'Este, 1976; Nye, 1993).

- **Case 5 –** General Douglas MacArthur’s 23 August decision to order the amphibious assault against North Korean forces at Inchon to occur on 15 September 1950 (Langley, 1979; Smith, 2012; Heinl, 1972)

Each of these were selected as examples of high-level military decisions that provided for a distribution of personalities and situational conditions, but were otherwise time-sensitive, critical, complex, relatively discrete and robustly supported by historical resources. Analysis of the literature related to these cases led to the identification of the details required to support their development as scenarios and their representation by stimuli. Case 6 was developed as a composite of historical events to counterbalance for the distribution of personality and situational attributes that resulted from the selection and development of the five historically based cases. These were further developed as scenarios and prepared for use as two runs for each scenario. The first was a fixed-factor run, which included all historically derived personality and situational factors in the stimuli. The second was a hybrid run where personality factors were planned for imputation from subject measures.

A seventh scenario (Scenario 0) was composed to represent average or normative situational conditions for a decision-making event. It was established as a rehearsal for subjects’ assessments of the six core scenarios and to provide a baseline of response data where all situational factors were at control settings. However, this scenario was only designed to support a single hybrid run. As such, personality factors were excluded.

Lexical descriptors provided the primary representation for experimental factors and subfactors for all runs. These were taken from the same descriptors established for use in Study 1[118] and prepared as two separate stimuli components: scenario narratives and word pictures. Appendix D provides discussion of the selection and analysis of the historical cases, the development of the composite case, the assignment of subfactor strength and lexical descriptors for each and their development as experimental scenarios. The descriptors assigned to each scenario are provided at Tables E.1 and E.2 of Appendix E. Factor strengths were calculated as the unweighted mean strength of component subfactors in each group. Table 3.1 above reports the assigned factor strength for each run.

3.5.1.1 Scenario Narratives

The fixed-factor run of the respective run-pairs for Scenarios 1 through 6 were supported by a narrative designed to convey to subjects a robust sense of the decision-making event. These narratives described:

- The strategic imperative for the event to indicate the criticality of the underlying military problem and the urgent need for a good decision.
- The decision maker's personal attributes, including personality, to convey a valid sense of a whole person.
- Situational factors related to the decision-making event to include:
    - The social composition of the decision-support group to convey a sense of group-dynamics.
    - The environmental conditions of the decision-making event to convey a sense of possible physical and cognitive effects.

[118] See Tables B.1, B.2 and B.3 at Appendix B for descriptors and descriptor groups.

- Characteristics of the event's deliberative format or structure to convey a sense of the possible effects of constraints over dialogue and process orderliness.

These narratives employed language tied to the descriptors and descriptor groups assigned to each scenario.[119] In order to prevent subjects' consideration of experimentally irrelevant factors arising from their prior knowledge of the decision makers or events, these were sanitized by removal of identifying details related to names, dates and places that might support recognition of the persons or events used as the basis for the scenario.

It was anticipated that these narratives would evoke valid percepts of an urgent problem requiring decision, the circumstances of the decision-making event and the personality of the designated decision maker. At the conclusion of each narrative, survey participants were directed to assume a role of responsibility over recommending conditions to the designated decision maker in advance of the hypothetical events.[120]

3.5.1.2 Scenario Word Pictures

Each scenario was supported by a word picture as stimuli.[121] These presented descriptor groups as representations of the experimental factors at the designated levels. As in Study 1, these were designed for presentation in a manner that would facilitate an automated versus consciously controlled response (Jacoby, 1991; Curran & Hintzman,

[119] These narratives are available in the document entitled "Personality and Situational Effects in Decision Making" included as a supplementary file to this report.
[120] Instructions to subjects were as follows: "Your Role: You are the Chief of Staff and have access to any required facilities, communications and other resources. You have the ability to influence the immediate priorities of the subordinate commanders and staffs. You are well-trusted by this commander and familiar with his strengths and weaknesses. He asks you to consider his recommended approach for the decision-making event. Will it produce the best possible decision? If not, what adjustments would you recommend?"
[121] For Scenario 0, the word picture was the only stimuli. For all other scenarios, these were employed as a summary of the scenario narratives as well as a prompt for subject assessments.

1995) to minimize subject processing workload and diminish the effects of explicit subject biases. Graphic cues were also included as guides for processing of word pictures and prompts for the assessment of decision quality and the suitability of situational conditions.

While redundant with the scenario narratives, the word pictures were necessary to anchor subject percepts related to the experimental factors near the target levels for each run. Since subjects were expected to interpret the scenario narratives in individually different ways, this anchoring was seen as critical to maximizing the potential for comparable interpretations of the stimuli across subjects. The following figure depicts the word picture stimuli from a single scenario (Scenario 3) of the survey.[122]

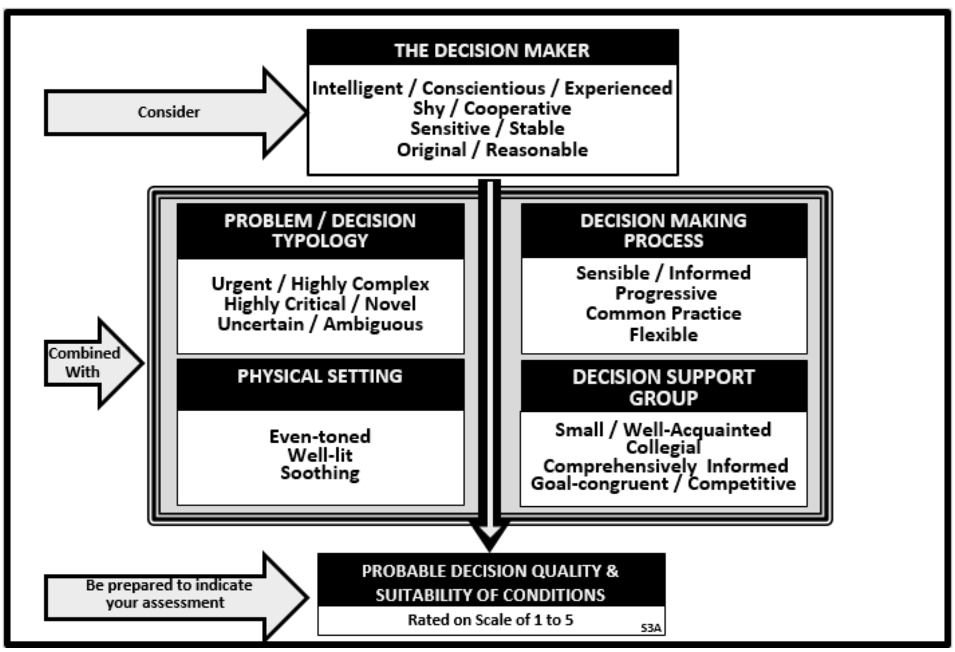

Figure 3.1: Study 2 Word Picture Stimuli

As shown in the above figure, descriptors and descriptor groups were arranged in five stimuli groups. The first group was entitled 'The Decision Maker.' For Scenario 0,

[122] These word pictures can be viewed in the document entitled "Personality and Situational Effects in Decision Making" included as a supplementary file to this report.

this group contained the phrase "You as you would describe yourself in a critical decision making situation" in lieu of the factor representations for *Psych*, *Extrav*, *Neuro, Intelligence, Experience* and *Conscientiousness.* For all other scenarios, this descriptor group depicted the descriptors assigned for as decision maker attributes in accordance with the experimental design. The second stimuli group contained the factor representation for *Decision Typology* at the control level. The three remaining groups contained the factor representations for *EnvStim*, *ProStruc* and *SptGrp* at the levels assigned for the respective scenario.

Placement of stimuli groups within the word picture was the same across scenarios to provide subjects an opportunity to gain efficiencies in stimuli processing through learning effects. Because it was assessed that the use of scenario narratives in combination with the word pictures would sufficiently diminish the likelihood of ordering effects on subject processing, none of the stimuli groups or descriptors were rotated within the word pictures. Finally, there were no additional or revised stimuli provided to support the hybrid experimental runs as the second run of the six core scenarios. These were initiated with a simple prompt for subjects to consider themselves in the place of the decision maker and then to make the four required assessments using the stimuli provided for the preceding, fixed-factor run.

3.5.1.3 Scenario Summaries

While not for use as stimuli, brief historical summaries were developed for presentation to subjects immediately after their completion of the paired runs from Scenarios 1 through 6. These informed subjects about historical details of the scenarios and to provide a distractor task aimed at inhibiting subject retrieval of salient details from completed scenarios (Beaman, Hanczakowski & Jones, 2014; and Fernandes & Moscovitch, 2000). These summaries omitted any reference to or representation of the experimental factors to prevent possible interference with the subject's assessment of subsequent scenarios. They were also seen as an incentive for subjects to select for continuation with additional scenarios (Sanders & Baron, 1975) by rewarding their curiosity about the previously completed scenario.

3.5.2 Other Survey Items

Just as in Study 1, the items required to support the measurement of subject personality were developed to elicit the degree to which subjects saw themselves as effectively described by each of the 18 trait personality descriptor pairs.[123] These items were prepared as a presentation of a single personality descriptor pair followed by a graphic prompt for subjects to indicate their response on a five-point Likert scale ranging from 1 (Completely Inaccurate Description of Me) to 5 (Perfect Description of Me). *SubjPsychFix*, *SubjExtravFix* and *SubjNeuroFix* were determined by six items each. The determination of *SubjLikBias* required the consideration of all 18 items.

Other subject classification data were elicited by single survey items. These included items for age, gender, primary vocation(s), years of work experience, enrollment in a professional or executive education program and organizational association. An additional six non-experimental items were developed to obtain subject self-reports of their knowledge and experience with decision making and related academic disciplines. These

[123] See Chapter 2, Section 2.5.1 for further discussion.

knowledge and experience measures required subject responses on a three-point Likert scale from 1 (low/limited/no knowledge or experience) to 3 (high/expert/extensive knowledge or experience).

3.6 Study 2 Analysis

3.6.1 Survey Administration and Participants

The survey was implemented between January 2018 and May 2019 through the commercial services of SurveyMonkey. There was no prescribed time or other conditions for participation except that respondents individually access the online survey through an invitation weblink, provide informed consent and complete the required survey items in accordance with the instructions. Scenarios were presented in a semi-randomized order by the SurveyMonkey platform such that Scenario 0 was always presented first, with subsequent scenarios presented in a random order without replacement.

There were 163 respondents to the invitation to participate with 27 persons who completed all required survey items.[124] Four participation records were excluded from the study results based upon the respondent's failure to meet either of the two inclusion

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[124] A total of 115 respondents completed informed consent protocols and the required subject classification items. Sixty-five respondents self-terminated before completing the first experimental run, thus indicating a lack of interest in the survey content. An additional 24 respondents self-terminated after completing experimental runs, but before completing all required subject measures at the end of the survey. Completion rates were dramatically higher for males than for females, and for respondents in the oldest age group. There was no practical method to estimate the total number of individuals invited for participation in the study. Direct recruitment occurred by email invitations sent by to associates of U.S. military organizations, professional military education programs and other graduate education programs. Other participants were indirectly recruited by these organizations or their associates by forwarded email invitations or publicly accessible weblinks. Additional invitation weblinks were established by this researcher on LinkedIn at: https://www.surveymonkey.com/r/J6CJ658 and on the Social Psychology Network at https://www.surveymonkey.com/r/Y6PTV3L.

criteria.[125] An additional record was excluded due to the individual's invalid pattern of response to personality measures. This provided a total of 22 subject records for analysis.[126]

Eighteen validated subjects were male, and four were female. Ten reported "military service" as a primary vocation or profession, with nine others reporting "business" and three reporting "academia" or "education".[127] The remainder of subjects reported other vocations including government, business, medical, and "other". The median age category was from "50 to 59" years of age, with "60 or older" as the modal response.[128] The median and modal response on experience with organizational decision making was "more than 21 years".[129]

It was concluded that these sample characteristics reflected low conformity with a theoretic decision maker population, primarily due to age and experience. On the other hand, these same qualities provided a highly qualified panel of judges to support the *policy-capturing* objectives (Aiman-Smith et al., 2002; Karren & Barringer, 2002).

Beyond the mandatory completion of the baseline scenario and run, the 22 subjects completed an average of 3.64 of the six core scenarios, each comprised of two experimental runs. These scenarios were unevenly represented in the survey results with between 11 and

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[125] All four of these rejected respondents reported being younger than 27 years of age with less than five years of "military, government, business or professional academic experience".

[126] Validated experimental data for Study 2 are available in the document entitled "Study 2 Response Data (Final)" included as a supplementary file to this report.

[127] Subjects were permitted to report more than one vocation or profession.

[128] Valid subjects by age category were: 0 for "Under 25"; 1 for "25 to 29"; 4 for "30 to 39"; 2 for "40 to 49"; 5 for "50 to 59"; and 10 for "60 or older".

[129] Valid subjects by experience category were: 0 for "Less than 1 year"; 1 for "1 to 5 years"; 2 for "6 to 10 years"; 3 for "11 to 20 years"; and 16 for "More than 21 years". Other experience measures recorded similar results. Subject self-assessments were correspondingly high on other knowledge and experiences measures with 17 subjects reporting "extensive experience" with organizational decision making.

16 completions of each.[130] This produced 182 experimental response data for *DxQual* and 546 response data for the three control policy assessments.

The 18 personality measurement items were used to determine the four personality factors for each subject using the same methods applied in Study 1.[131] This produced subject measures that were approximately normally distributed for all three factors with characteristics as shown in the following table:

Table 3.2: Study 2 Subject Personality Measures

SUBJECT PERSONALITY FACTOR	MEAN	VARIANCE	MIN VALUE	MAX VALUE
***Subject Psychoticism* (*SubjPsychFix*)**	0.543	0.311	-0.900	1.505
***Subject Extraversion* (*SubjExtravFix*)**	0.561	0.503	-1.292	1.880
Subject Neuroticism* (*SubjNeuroFix)	-0.424	1.106	-2.668	1.048
Subject Dissimulation* (*SubjLikBias)	0.288	0.085	-0.333	0.889

As in Study 1, these results indicated that the sample means for the three primary subject personality measures (*SubjPsychFix*, *SubjExtravFix*, and *SubjNeuroFix*) were within approximately one standard deviation of the estimated population means (0) for the factors, with strong central tendencies and dispersion across the measured ranges.

3.6.2 Decision Quality

Subject responses for *DxQual were* required on a five-point Likert scale. This permitted response values on the interval (1,5). The mean response was 3.725 with sample

[130] Runs by scenario were 22, 32, 24, 28, 22, 32, and 22 for Scenarios, 0 through 6 respectively.
[131] See Chapter 2, Section 2.7.2, footnote 89 for discussion of the method applied to determining subject measures. For their use as imputed factors, these measures were rescaled to align with the distribution of fixed personality factors. Due to its larger sample size, the subject personality factor distributions from Study 1 were used for deriving the scalar adjustments to the Study 2 distributions.

variance measured at 0.852. Cronbach's alpha was evaluated at 0.96.[132]

Upon visual and statistical examination, the experimental results seemed to defy the *Yerkes-Dodson law* (Wickens & Holland, 2000) by demonstrating no convincing evidence of curvilinear relationships between situational factors and the response data. Given that the personality factors similarly lacked evidence of a curvilinear relationships with *DxQual*, no transformations of predictor variables were undertaken. Residual plots and model fit analysis also warned against any transformation of the response.

The response data were re-centered on zero (0) and analyzed in R with a linear mixed-effects model applying the restricted maximum likelihood approach. The six core experimental factors were included as independent variables. Eight first-level factor interactions and three second-level interactions were also included reflecting the formal experimental hypotheses proposed for this study. Selected random covariates were also included in the mixed model to ensure accountability for otherwise explainable variance including within-subjects variance.[133] Invariant experimental control factors were not included.

The following table depicts the fixed effects of this analysis:

Table 3.3: Mixed-model Fixed Effects[134]

[132] Pairwise t-tests confirmed that the results were comparable for four relevant subsets of experimental response data. Evaluated subsets included: baseline runs (22 total); non-baseline runs (160 runs); fixed personality factor runs (80 runs); and random personality factor (hybrid) runs (102 runs).

[133] Several concomitant factors covariates and factor interactions were evaluated for inclusion in the final analytic models. Most of these proved to be insignificant in each of several model variations and were thus excluded from the selected models. Personality factor interactions were also excluded on this basis. Others were determined to be highly collinear with coefficients converging on 0, such that they were required for exclusion to prevent singularities in the regression analysis.

[134] The complete results of mixed-model regression for Study 2 are provided at Appendix D.

Experimental Response: Decision Quality (DxQual) Mixed Model Regression Results (Fixed-factors Only)						
Fixed Effects	**Estimate**	**Std Error**	**t Value**	**p Value**	**Significance** * : p < 0.25 ** : p < 0.10 *** : p < 0.05	**Remarks**
(Intercept)	0.648	0.189	3.433	0.001	***	
Psych	-0.016	0.234	-0.070	0.945		Implicated
Extrav	0.271	0.178	1.525	0.131	*	Implicated
Neuro	-0.133	0.110	-1.209	0.230	*	
EnvStim	-0.348	0.511	-0.681	0.497		Implicated
ProStruc	0.086	0.213	0.401	0.690		
SptGrp	-0.009	0.242	-0.037	0.970		Implicated
Psych:EnvStim	0.945	0.612	1.544	0.126	*	Implicated
Psych:ProStruc	-0.275	0.282	-0.973	0.333		
Psych:SptGrp	-0.796	0.330	-2.417	0.018	***	H_{PXG} Supported
Extrav:EnvStim	-0.554	0.469	-1.181	0.241	*	Implicated
Extrav:SptGrp	0.361	0.205	1.762	0.082	**	H_{EXG} Supported
Neuro:EnvStim	0.118	0.295	0.399	0.691		
Neuro:SptGrp	0.007	0.131	0.051	0.959		
EnvStim:SptGrp	0.336	0.644	0.521	0.604		Implicated
Psych:EnvStim:SptGrp	-1.592	0.782	-2.035	0.045	***	H_{PXCXG} Supported
Extrav:EnvStim:SptGrp	0.862	0.551	1.565	0.121	*	H_{EXCXG} Supported
Neuro:EnvStim:SptGrp	-0.043	0.371	-0.115	0.909		

The marginal R-squared was evaluated at 0.270 with a conditional R-squared of 0.303[135] and a residual variance of 0.639 for the selected regression model. It was no surprise that these results indicated an unimpressive model fit. However, it was unexpected that the results provided almost no direct support for confirming the six personality and situational factors as significant predictors of *DxQual*.[136] Nonetheless, factor interactions between personality and situational factors implicated four of the six independent variables

[135] Marginal R-squared measures variance attributable to fixed-factors. Conditional R-squared measures variance attributable to both fixed and random factors (Nakagawa & Schielzeth, 2013).

[136] Separate evaluation by mixed models that excluded factor interactions reported statistical significance at p < 0.05 of main effects for *Psych, Extrav* and *SptGrp*. The statistical significance of *Neuro, EnvStim* and *ProStruc* could only be directly confirmed as significant by unreasonable coercion of model components.

as required components in the hierarchy of mixed model effects. Just as with Study 1, the low R-squared was largely attributed to the noisy nature of the experimental method. Nonetheless, these results provided no support for attributing explanatory power to effects related to *Neuro* or *ProStruc.*

This response data was reevaluated with a revised mixed model combining the three situational factors as a single factor (*Situational Stimulation (SitStim*)) to examine for generalized situational effects and interactions as might be predicted by the concept of *Situational Strength* (Meyer & Dalal, 2009; Meyer, Kelly & Bowling, 2017). From this examination, only the *Extrav* main effects were indicated as significant.[137] However, the *Psych:SitStim* interaction was also indicated as significant according to the relaxed acceptance thresholds for this experiment at $p = 0.053$. This result provided support for the possible use in future investigations of aggregate situational stimulation as a predictor for *Situational Strength* effects on decision making performance.[138]

Considered together, these two evaluations of the *DxQual* response data provided justification for the continued inclusion in *WREM* of all independent variables except for *Neuro* and *ProStruc*. Control policy assessments were then analyzed to obtain confirmation/disconfirmation by other means of main effects and key interactions related to specific situational control options.

3.6.3 Control Policy Assessments

[137] *Psych* and *Extrav* were both reported as $p < 0.10$, which did not meet the acceptance thresholds for the experiment. The main effect for *SitStim* was indicated as significant at $p < 0.0001$ when interactions were excluded from the mixed model used for analysis.

[138] *SitStim* was envisioned as the absence of constraint on situational stimulation and as an approximation for a ‘weak situation’ as an adaptation of concepts for *Situational Strength* (Meyer & Dalal, 2009; Meyer, Kelly & Bowling, 2017).

Three survey items elicited subject assessments of the need for adjustment to the stimulation levels related to the fixed situational factors for each experimental run. Subjects were required to recommend for a decrease, no change or an increase to stimulation.[139] The summary statistics taken from the three separate control policy assessments are indicated in the following table:

Table 3.4: Study 2 Control Policy Assessments

Control	Assessment Frequency			Mean	Variance
	Decrease (-1)	No Change (0)	Increase (1)		
Environmental Stimulation Level (EnvStimLvl)	17	130	35	0.099	0.277
Process Structure Stimulation Level (ProcStimLvl)	29	108	45	0.088	0.401
Support Group Stimulation Level (GrpStimLvl)	36	95	51	0.082	0.474
TOTALS/AVERAGES	82	333	131	0.090	0.383

There was an evident bias for recommending against changes to the situational conditions with 'No Change' recommended to 61 percent of the 546 control policy assessments. However, after a closer look, a general disinclination for control was disconfirmed. There was also a high correspondence between control recommendations and the assessments of *DxQual*. In fact, there were no instances where subjects failed to recommend for change to at least one situational condition when they assessed *DxQual* as poor or very poor. Additionally, adjustments were recommended to at least one condition in nine of the 34 runs where subjects assessed 'Very Good' decision quality.

The subjects' willingness to recommend for adjustments even when *DxQual* was 'Very Good' provided a basis for inference that the subject's control selections were

[139] These responses were required on a 3 point Likert scale adjusted to -1, 0 or 1.

rationally selective and tied to the represented conditions of the events. It was also determined that subjects demonstrated the same inclination/disinclination for control whether or not they were considered as the decision maker. The results were similar for each relevant subset of policy control response data.[140]

The three sets of *policy-capturing* response data were then evaluated individually by linear mixed model regression.[141] The six core experimental factors, two random factors (*Subject* and *SubjLikBias*) and four interactions were included in analysis of each control policy. The fixed effects of these analyses are provided at Tables G.1, G.2 and G.3 of Appendix G where all three control policy assessments reported significant main effects and/or interactions involving each policy's primary situational factor (i.e., *EnvStim* for *EnvStimLvl*, *ProStruc* for *ProcStimLvl* and *SptGrp* for *GrpStimLvl*).

Significant interactions for *ProcStimLvl* (see Table G.2 at Appendix G) also supported the inference of a key one-to-one relationship between *ProStruc* and *Psych*, while analysis of *GrpStimLvl* (see Table G.3) supported the inference of a similar relationship between *SptGrp* and *Extrav*. However, the same did not hold true for analysis of *EnvStimLvl* with respect to the relationship between *EnvStim* and *Neuro* (See Table G.1).

Beyond this, the *ProStruc* and *SptGrp* factors demonstrated significant to marginally significant effects or interactions across all three control policies, while *EnvStim* indicated significant to marginally significant main effects for two of the three control policies. *Extrav* and *Psych* were both indicated as significant factors or implicated

[140] The relevant subsets of control policy response data were the same as addressed in footnote 132.
[141] Marginal//conditional R-squared was reported as 0.347 / 0.530, 0.151 / 0.350 and 0.264 / 0.468 for mixed models related to response data for *EnvStimLvl*, *ProcStimLvl* and *GrpStimLvl* respectively.

by significant interactions for one control policy each. Collectively, these assessments provided confirmation of the significance or implication by interactions of all *WREM*'s independent variables except for *Neuro.*[142]

Separate analyses were performed to identify personality-based biases for or against active control. *SubjExtravFix* demonstrated relatively large random effects on all three policy control assessments, while *SubjPsychFix* demonstrated large random effects only for the *ProcStimLvl* assessment. However, there was no evidence of any random effects related to *SubjNeuroFix* in any of the three evaluations. These results supported acceptance of the hypothesis that decision makers' judgments concerning the need for active situational controls are affected by their measured personality, specifically including *SubjPsychFix* and *SubjExtravFix*.

3.6.4 Analysis Summary

The experimental and *policy-capturing* results were largely congruent, with the main contrasts arising from the effect sizes of selected second-level interactions and the increased significance of *Psych, Extrav*, and *ProStruc* main effects as revealed by the control policy assessments. These cumulative results also supported a conclusion that the construct validity of the factors and the policy controls was adequate to support the experimental approach and the achievement of this study's objectives.

3.7 Discussion and Summary

3.7.1 Study Findings

[142] The control policy assessments were revaluated to test for interactions between personality factors. As a result, *Neuroticism* was implicated by three significant factor interactions (*Psych:Neuro:ProStruc, Extrav:Neuro:ProStruc* and *Extrav:Neuro:EnvStim*). The *Psych:Extrav:ProStruc* interaction was the only other significant interaction implicating two or more personality factors.

Although it was not the focus of any of the formal hypotheses, this study's results directly supported the continued inclusion of five of six core experimental factors as *WREM* components. The significance of *Psych*, *Extrav*, *EnvStim*, *ProStruc* and *SptGrp* was directly demonstrated as significant by main effects or implicated by factor interactions in either the experimental response data (Table 3.3 above) or the control policy assessments at Tables G.1, G.2 or G.3 of Appendix G. However, the lack of evidence for *Neuroticism*-related effects was surprising given the stark contradiction with the results of *Study 1*.

As presented in Chapters 1 and 2 of this report, the *EnvStim* factor was originally developed and included in *WREM* for the specific purpose of mechanizing interaction effects with *Neuro*. That this interaction was not revealed except by coercion of the analytic models suggests questions about experimenter effects related to the methods or stimuli of the current study, including possible construct invalidities arising from the concurrent employment of *Neuro* and *Conscientiousness* as factors. Given *Neuro*'s results from Study 1 and the concept's prominence and broad acceptance within personality psychology, it was assessed that the rejection of *Neuro* and its removal from *WREM* was not yet justified. As such, it was decided that *Neuro* would be retained as a personality component in *WREM* until it could be instantiated as a factor by more thoroughly validated means and retested under more-realistic conditions.

The experimental and *policy-capturing* results supported the acceptance of hypotheses related to six of the eight first-level interactions and two of the three second-level interactions The accepted hypotheses included: H_{PXG} (*Psych: SptGrp*); H_{PXS} *(Psych:ProStruc);* H_{EXG} (*Extrav:SptGrp*); H_{EXCXG} (*Extrav:EnvStim:SptGrp*); H_{EXG} (*Extrav:SptGrp); H_{CXG}* (*EnvStim:SptGrp); H_{PXCXG}* (*Psych:EnvStim:SptGrp);* and H_{EXCXG}

(*Extrav:EnvStim:SptGrp)*. The effects represented by these hypotheses were thus accepted for continued inclusion in *WREM*. Rejected hypotheses included: H_{NXC} (*Neuro:EnvStim);* H_{NXG} (*Neuro:SptGrp);* and H_{NXCXG} (*Neuro:EnvStim:SptGrp).*

The relatively small effect sizes for the main effects was seen as important to the logic of *WREM* as this supports this researcher's original expectation that there would be no particular advantages associated with any one personality or situational factor except as those factors interact to facilitate or inhibit good decision making. The relatively larger effects sizes for the interactions support inferences that factor-combinations represent the dominant predictors of decision making performance in place of the main effects.

In contrast to Study 1 results, this study reported comparable effect sizes between personality and situational factors and their interactions. This has been attributed to differences in the experimental methodology from Study 1 to Study 2 including: the loss of marginal significance for all main effects resulting from the inclusion of additional factor interactions in the analytic models; the more robust representation of all factors in the stimuli; and the increased experimental design points included for situational factors. This permitted a tentative conclusion that the adjustments made from Study 1 to moderate the disproportionality of personality and situational factor representations were successful.

The absence of evidence for curvilinear relationships between independent variables and the experimental response was perplexing. It was considered that the examined ranges of the factors may have been too narrow to permit the identification of performance break-points on the low and high ends of stimulation. It was also considered that the realism of the experiment was a possible cause. It was tentatively concluded that this aspect of the study should be more thoroughly considered through analysis of the experimental response surface.

3.7.2 Study Limitations

As with Study 1, the primary limitation of this study arose from the representation of the decision-making events by induction or mental simulation, and the implied cognitive workload this imposed on subjects. Nonetheless, it was once again accepted that the selected experimental approach and stimuli were suitable and economical means to meet the requirements of this research.

The study sample itself limits the generalizability of this study's results. Despite marginal improvements on vocational diversity from Study 1, the Study 2 sample size was much smaller, older and more experienced. And, while age and experience were certainly advantageous for the *policy-capturing* aspects of the study, these skewed characteristics still set the sample well-apart from a random representation of the real-world decision making population. That said, these same sample characteristics suggest that the entire study might be best considered as an experimental implementation of the *policy-capturing* technique (Aiman-Smith et al., 2002). Depending upon the intent for further research, reinvestigation against a more representative sample would be preferred to validate *WREM*'s applicability to normative decision makers.

Unique to this study, the imputation of subject self-reported measures as fixed-factors created a systemic threat to the construct validity of the investigated personality factors. It was recognized that, even if subjects performed their mental role substitutions effectively, they must have included their own self-concepts for intelligence, conscientiousness and experience in the substitution. Depending upon how distinct subjects' personal attributes were from those of the scenario-based decision makers with respect to these otherwise controlled variables, the implications were not insignificant. It was tentatively concluded that this threat may have contributed to the dramatic loss of significance seen for the *Neuroticism* factor as compared to the Study 1 results.

Regrettably, the literature among the relevant disciplines provides no recommended methods to conduct such systemic substitutions of fixed-factors with random data. Various statistical tests were conducted to detect possible distinctions between the data and results of fixed-factor runs and hybrid runs, and these indicated no notable differences in means or variance structures between the separate subsets of Study 2 data. In addition, mixed model regression produced similarly impactful results for personality factors in all subsets of response data. Nonetheless, it may be preferred to avoid the imputation of random data as fixed experimental factors, both to preserve the valid representation of those fixed-factors and to obtain greater control of and balance within the experimental design.

The significance of the *Psych:ProStruc* interaction in the control policy analysis raised another issue related to construct validity. This interaction, when compared to the same interaction in the *DxQual* response data, demonstrated an important distinction between a subject's explicit acknowledgement of the need to apply a control policy, and their negation of potential effects arising from the absence of such control. This seemed to suggest possible construct validity issues for both *Psych* and *ProStruc*, which bear further consideration if intended for use in other research.

As with Study 1, the control over *Intelligence*, *Experience* and *Decision Typology* created gaps in the holistic validation of *WREM* and its applicability to other types of decisions and possibly less qualified decision makers. The exclusion of *Emergent Attributes* and E*xternal Factors* from examination further detracted from the model's generalizability. It was concluded that all of these prospective factors warrant increased attention where they can be practically accommodated alongside *WREM*'s six core factors.

3.7.3 Study Conclusions

The objective of this study was achieved with eight of 11 of its hypotheses accepted. According to the judgment of this study's subjects, specific situational factors do variably affect decision quality according to the personality of the decision maker. Given the dominance of the interaction effects and the relative sparseness of main effects, the six core experimental factors and hypothesis-supported interactions together constitute a plausible theoretical basis for the further evaluation of *WREM* as a parametric model for the optimization of decision quality.

In conclusion, this study set the necessary conditions to support analysis of the *WREM* response surface and the development of practical situational control options for organizations to apply toward the optimization of decision making circumstances with specific regard for the personality of the decision maker. Development of these control options is the primary subject of the next chapter.

CHAPTER 4. *WREM* RESPONSE SURFACE ANALYSIS AND *OPTIMIZATION SOLUTIONS*

4.1 Introduction

Study 2 (Chapter 3) set conditions for the examination of the *War Room Effects Model* (*WREM*) as a parametric model of decision-making performance. As recorded in this chapter, *WREM'*s parameters were further analyzed to support the development of a *system of situational control* for the optimization of decision-making performance according to the personality of the decision maker. Selected techniques were drawn from response surface methodology (Kutner, Nachtsheim, Neter & Li, 2005; C. Wu & Hamada, 2009; Law, 2007) and applied to the identification and evaluation of *optimization solutions* that are applicable to persons measured by the *PEN model* of personality (H. Eysenck, 1990, 1998; H. Eysenck & M. Eysenck, 1985).

To support this analysis, the *WREM* response surface was generated by linear predictions of *Decision Quality* with factors and parameters derived from the Study 2 mixed model regression results.[143] This response surface supported the development of recommended control settings – or optimization rules – for each situational factor as they uniquely apply to 27 discrete personality factor combinations.

Deterministic and stochastic simulations were implemented to generate six-dimensional arrays of response data with one dimension indexed for each of *WREM's* predictor variables. For the deterministic version, the six predictors were established as

[143] See Chapter 3, Section 3.6.2 and Table 3.3.

multi-level fixed-factors. This response surface supported the identification of an optimal situational setting for each combination of three-level personality factors. For the stochastic version of the response surface, predictors were randomized to support sensitivity analysis of the prospective *optimization solutions*. This was replicated many times to identify probabilistic changes to indicated optimal conditions and to estimate the reliability of the prospective *optimization solutions*. For both versions, *DxQual* was evaluated by applying a linear prediction equation to combinations of the predictors. The following table displays this equation.[144]

Table 4.1: *DxQual* Linear Prediction Equation

$DxQual =$	
0.648	Intercept Component
$-0.016Psych$ $+0.271Extrav$ $-0.133Neuro$	Personality Factor Components
$-0.348EnvStim$ $-0.086ProStruc$ $-0.009SptGrp$	Situational Factor Components
$-0.945(Psych\mathrm{X}EnvStim)$ $-0.275(Psych\mathrm{X}ProStruc)$ $-0.796(Psych\mathrm{X}SptGrp)$ $+0.554(Extrav\mathrm{X}EnvStim)$ $+0.361(Extrav\mathrm{X}SptGrp)$ $+0.118(Neuro\mathrm{X}EnvStim)$ $+0.007(Neuro\mathrm{X}SptGrp)$	First-level Interaction Components
$-1.592(Psych\mathrm{X}EnvStim\mathrm{X}SptGrp)$ $+0.862(Extrav\mathrm{X}EnvStim\mathrm{X}SptGrp)$ $-0.043(Neuro\mathrm{X}EnvStim\mathrm{X}SptGrp)$	Second-level Interaction Components

4.2 Methodology

As mentioned in the introduction to this chapter, this analysis applied selected RSM techniques (C. Wu & Hamada, 2009; Law, 2007; Kutner et al., 2005) to develop a testable

[144] The factors referenced in this equation are defined in Chapter 3, Section 3.2 of this report.

system of personality-informed situational controls. It began with the quantitative analysis of the *WREM* response surface data. This included the detailed examination of a deterministic response surface to identify optimal situational factor settings as the prospective *optimization solutions* for each of the 27 personality factor combinations. A stochastic (or randomized) version of the response surface supported the identification of alternative *optimization solutions* and estimates for the reliability of each.

The final stage of response surface analysis entailed the inspection and evaluation of conditional response contours derived from the deterministic response surface. These contours were used to conditionally validate the prospective *optimization solutions* identified by quantitative analysis. However, they also supported the identification of specific surface features that affect the reliability of each optimization rule within the *optimization solutions*. These combined analyses culminated with the testing of the *optimization solutions* by stochastic simulation as a *system of situational control*.

4.2.1 Quantitative Analysis of the Response Surface

For the first part of quantitative analysis, six continuous predictors were established at three levels for each, with levels defined as intervals for low, moderate and high factor strength. Factors were sampled at 13 uniformly distributed points on the range established for each and *DxQual* was evaluated for the full-factorial array of sampled points.

Situational factors were established with three adjacent intervals on the range (-1.5, 1.5) with interval widths set to one (1.0). The following table depicts intervals and sampled points for situational factors. [145]

Table 4.2: Situational Factor Intervals and Levels

Low Factor Level			Moderate Factor Level			High Factor Level		
Interval	Median	Sampled Points	Interval	Median	Sampled Points	Interval	Median	Sampled Points
(-1.5, -0.5]	-1	-1.500 -1.250 -1.000 -0.750	(-0.5, 0.5)	1	-0.500 -0.250 0.000 0.250 0.500	[0.5, 1.5)	1	0.750 1.000 1.250 1.500

Personality factors were established in three intervals on the range (mean – 1.5 x sd, mean + 1.5 x sd) for each factor, with interval widths set at one standard deviation (*sd*) for each factor. [146] The following table depicts intervals and sampled points for the factors.

Table 4.3: Personality Factor Intervals and Levels

	Low Factor Level			Moderate Factor Level			High Factor Level		
	Interval	Median	Sampled Points	Interval	Median	Sampled Points	Interval	Median	Sampled Points
Psych	(-0.250, 0.278]	0.014	-0.250 -0.118 0.014 0.146	(0.278, 0.806)	0.542	0.278 0.410 0.542 0.674 0.806	[0.806, 1.335)	1.071	0.939 1.071 1.203 1.335
Extrav	(-0.703, 0.006]	-0.348	-0.703 -0.526 -0.348 0.171	(0.006, 0.716)	0.361	0.006 0.184 0.361 0.538 0.716	[0.716, 1.606)	1.070	0.893 1.070 1.247 1.425
Neuro	(-1.603, -0.696]	-1.149	-1.603 -1.376 -1.149 -0.923	(-0.696, 0.211)	-0.242	-0.696 -0.469 -0.242 -0.016 0.211	[0.211, 1.118)	0.664	0.438 0.664 0.891 1.118

[145] These intervals exceeded the formerly examined ranges of *WREM*'s situational factors. However, this expanded range enabled consideration for error and other variance related to factor measurement. It also supported the extrapolation of findings beyond the limits applied to the experimental factors.

[146] Factor means and standard deviations were calculated from the Study 2 experimental design matrix.

The response surface was generated in *R* using the full-factorial combinations of these sampled points.[147] The data were analyzed in blocks, with one block for each of the 3^3 combinations of the three-level personality factors.[148] From the results of this analysis, optimal situational settings – or optimization rules – were identified for each block with one rule established for each three-level situational factor. Once combined, these three optimization rules were accepted as prospective *optimization solutions.*

These *optimization solutions* were then subjected to sensitivity analysis by the randomization of predictors across multiple replications of a stochastic response surface. This simulation was designed to investigate the reliability of the proposed *optimization solutions* under exposure to uncertainty. For each of 10,000 replications, random variables were drawn from the three intervals of each predictor. The full-factorial combinations of these random variables were then evaluated by the prediction equation to produce a 3^6 (729) component response surface array.

From these data, probabilities were estimated for the likelihood that each situational factor combination would produce the maximum value for *DxQual* (*max(DxQual)*) within any personality block across replications. These probabilities were accepted as estimates of reliability for each situational factor combination as an *optimization solution*. According to the estimated reliability of each, primary and alternate *optimization solutions* were

[147] *R* code for generation and stochastic simulation and analysis of the *WREM* response surface is available the document entitled "*WREM* Response Surface Model and Simulation R Code" included as a supplementary file to this report.

[148] The use of three levels/intervals for factor strength was an arbitrary constraint placed on the and analysis of the *WREM* response surface. Slope inversions identified within 10 of the 27 personality blocks provide rationale for increasing the number of examined levels/intervals. The *WREM* response surface allows for evaluation of *Decision Quality* as predicted by factors at any level on their established continuous ranges.

tentatively assigned to all personality factor combinations.[149]

4.2.2 Evaluation of Conditional Response Contours

The second method applied to the analysis of the response surface was the inspection and evaluation of conditional response contours (Kutner et al., 2005). Each of these graphically displayed *DxQual* predictions across the established ranges of one continuous situational factor and one continuous personality factor. These response contours and their supporting data permitted the visual identification and statistical confirmation of conditional performance maximums and minimums and other key contour features for each personality block. They also supported estimation of the slope of decreases to *DxQual* where situational factor settings were offset from optimal levels.

Fifty-six conditional response contours were selected for analysis and generated in *R.* Each included two indexed factors established at 51 uniformly distributed points on the intervals indicated at Tables 4.2 and 4.3 above. Non-indexed factors were set to the median of the factor's low, moderate or high interval depending on the selected contour perspective. Three contour perspectives were produced for each of the 12 distinct combinations of one three-level situational factor (including *EnvStim, ProStruc, SptGrp* and *SitStim*[150]) and one three-level personality factor (including *Psych, Extrav* and *Neuro*).

[149] Optimization rules are presented in Tables H.1, H.2 and H.3 of Appendix as components of each *optimization solution* and the *system of situational control*. Alternative criteria were considered for the selection of prospective *optimization solutions* including maximum *mean(DxQual)*, maximum *max(DxQual)* and maximum *min(DxQual)* across personality blocks. For 25 of 27 blocks, the situational combinations with highest estimated reliability also produced maximum *mean(DxQual).* As such, reliability was accepted as the single criterion for tentative assignment of *optimization solutions*.

[150] *SitStim* response contours were included in this analysis to obtain insights on the potential impact of concurrent changes to multiple situational factors on continuous intervals. *SitStim* was indexed as a single situational factor consistent with its use as a regression factor in Chapter 3, Section 3.6.2 of this report. *SitStim* was evaluated as $\sqrt[3]{(EnvStim \times EnvStim \times SptGrp)}$ for ($EnvStim = EnvStim = SptGrp$) on the interval (-1.5, 1.5). *SitStim* contours provided graphic coverage for 19 of 27 personality factor combination blocks.

The first contour perspective in these groups of three had non-indexed factors set to low, the second to moderate and the third to high. An additional 20 response contours were produced to support the analysis of personality factor combinations not well-represented by the 36 perspectives described above. Each of these 56 conditional response contours provided unique insights about changes to *WREM* factor interactions over the range of indexed factors, and across selected combinations of three-level, non-indexed factors.[151]

4.3 Response Surface Analysis Results

The next two sections describe the results of quantitative and response contour analysis , which led to the development of optimization rules, *optimization solutions* and other considerations for the proposed *system of situational control*.

4.3.1 Results of Quantitative Analysis

The following table reports the summary statistics obtained by generating and evaluating the deterministic and stochastic response surfaces:

Table 4.4: Deterministic vs. Stochastic Summary Statistics

Response Surface Version	*n*	*mean(DxQual)*	*var(DxQual)*	*min(DxQual)*	*max(DxQual)*	Min *Block Mean*	Max *Block Mean*
Deterministic Response Surface	4.827M	0.769	1.414	-6.929 ***pEn*** $C_HS_LG_L$	10.331 ***PeN*** $C_HS_LG_L$	0.408 ***PeN***	1.130 ***pEn***
Stochastic Response Surface	7290K	0.769	0.980	-6.193 ***pEn*** $C_HS_LG_L$	9.466 ***PeX*** $C_HS_HG_L$	0.445 ***PeN***	1.091 ***pEn***

A two-sample t-test (Welch, 1947) confirmed that the means for the two sets of response

Because of the manner of its composition as a factor, *SitStim* contours were not useful for the identification of specific *optimization solutions* because there are infinitely many solutions for *SitStim's* three subfactors for any given value of *SitStim*.

[151] These are available in the document entitled "*WREM* Response Contours" included as a supplementary file to this report. This includes a cross-reference for all conditional response contours and personality combination blocks.

surface data were not unequal at $t = 0.165$ and $p = 0.869$. Summary statistics by personality block for the two sets of response surface data are provided at Table H.1 of Appendix H. For both the deterministic simulation, the maximum predicted value for *DxQual* (*max(DxQual)*) was identified at 'High *EnvStim*/Low *ProStruc/*Low *SptGrp'* (***$C_HS_LG_L$***)[152] in the 'High *Psych*/Low *Extrav*/High *Neuro'* (***PeN***)[153] block. For the stochastic simulations, *max(DxQual)* was identified at ***$C_HS_HG_L$*** in the ***PeX*** block. The same situational factor combination (***$C_HS_LG_L$***) produced minimum *DxQual* (*min(DxQual)*) in the ***pEn*** block for both the deterministic and stochastic simulations. As an aside, the analysis of both simulations revealed that personality factor combinations including '*High-Psych*' generally predicted better decision-making performance than the other combinations.

In the deterministic simulation of the response surface, *max(DxQual)* was only produced by three different situational combinations (***$C_HS_LG_L$, $C_LS_HG_L$*** and ***$C_LS_LG_L$***) across personality blocks.[154] The stochastic simulation confirmed that one of these combinations was always *most likely* to produce *max(DxQual)* for any personality block. In addition, the two simulations separately indicated the exact same optimal situational conditions for 23 of 27 personality blocks.[155] However, the stochastic simulations also indicated the likelihood that all 27 situational factor combinations would occasionally produce *max(DxQual)* for one or more personality blocks, with probabilities ranging from

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[152] The annotation for situational factor combinations includes 'C' for *EnvStim*, 'S' for *ProStruc* and 'G' for *SptGrp*. Subscripts for each factor include 'L' for low, 'M' for moderate and 'H' for high settings.

[153] The annotation for personality factor combination blocks includes 'p', 'X' or 'P' for the low, moderate or high setting of *Psych*, 'e', 'X' or 'E' for *Extrav* and 'n', 'X' and 'N' for *Neuro*.

[154] This simulation generated a single response surface from the full-factorial combinations of six 13-level personality and situation factors. *Max(DxQual*) was identified once for each personality combination block.

[155] The four personality blocks that were indicated with different optimal situational settings between the deterministic and stochastic simulations were ***XEX*** and ***XEN, peN, Xen, XEX*** and ***XEN***.

0.427 to 0.0001 in any one replication.[156] Situational factor combinations reported with the highest probabilities were tentatively accepted as primary *optimization solutions* for the associated personality blocks. Situational combinations with the second and third highest probabilities were accepted as alternate *optimization solutions*.

This resulted in the identification of seven different situational factor combinations as *optimization solutions* as indicated in the table below.

Table 4.5: Situational Factor *Optimization Solutions*

Primary *Optimization Solutions*	**Alternate *Optimization Solutions***
$C_LS_HG_L$ Set *EnvStim* to low (≤ -1.0) Set *ProStruc* to high (≥ 1.0) Set *SptGrp* to low (≤ -1.0)	$C_HS_HG_L$ Set *EnvStim* to high (≥ 1.0) Set *ProStruc* to high (≥ 1.0) Set *SptGrp* to low (≤ -1.0)
$C_HS_LG_L$ Set *EnvStim* to high (≥ 1.0) Set *ProStruc* to low (≤ -1.0) Set *SptGrp* to low (≤ -1.0)	$C_LS_MG_L$ Set *EnvStim* to low (≤ -1.0) Set *ProStruc* to moderate (~ 0.0) Set *SptGrp* to low (≤ - 1.0)
$C_LS_LG_L$ Set *EnvStim* to low (≤ -1.0) Set *ProStruc* to low (≤ -1.0) Set *SptGrp* to low 1.0)	$C_HS_MG_L$ Set *EnvStim* to high (≥ 1.0) Set *ProStruc* to moderate (~ 0.0) Set *SptGrp* to low (≤ -1.0)
	$C_MS_LG_L$ Set *EnvStim* to moderate (~ 0.0) Set *ProStruc* to low (≤ -1.0) Set *SptGrp* to moderate (~ 0.0)

Combined with other information obtained by analysis of response contours, these were assigned as either primary or alternate *optimization solutions* to personality blocks as recorded in Section 4.4 below.

[156] Table H.2 at Appendix H depicts the estimated probability for personality/situational factor combinations to produce *max(DxQual)* for any one replication of the stochastic response surface simulation. However, a total of 350 of the 729 personality/situational combinations never produced *max(DxQual)* in any of the 10,000 randomized replications. In addition, no situational factor combination produced *max(DxQual)* more than 42.7 percent of the time for any personality block.

Further evaluation of the response surface data revealed two patterns related to the prospective *optimization solutions*. The first was that all three situational factors were at low or high settings for all primary *optimization solutions*. The second pattern was that 'Low *SptGrp'* was indicated as the primary *SptGrp* factor setting for all personality blocks.

Given that the response data were generated from a first order linear equation, it was not unexpected that the *DxQual* maxima and minima would always fall at the limits of predictor intervals. On the other hand, the consistency of *SptGrp*'s influence on the response surface was unexpected, especially given the factor's near-zero coefficient in the prediction equation (see Table 4.1). However, *SptGrp* is implicated in seven of the eleven interaction components of the prediction equation, and all with practically significant coefficients. Because of this, *SptGrp*'s cumulative leverage on the response induced a relatively low upper limit for *DxQual* predictions when *SptGrp* was set to moderate or high. In fact, when set at moderate and high levels, the factor only predicted *max(DxQual)* in approximately one percent of the replications across personality blocks.

4.3.2 Results of Response Contour Analysis

Conditional response contours were used to verify the findings from the quantitative analysis of the deterministic response surface data, and to identify and analyze other contour features that could potentially affect the implementation of the prospective *optimization solutions*. From these contours, range-restricted *DxQual* minimums and maximums were identified along with the estimated slope of decreases to *DxQual* where situational factors were offset from the settings indicated by an *optimization solution*. Other contour and slope features were analyzed for use in the evaluation of optimization outcomes, and as might inform the selection and application of the *optimization solutions*.

4.3.2.1 Range-restricted Maximums and Minimums

Range-restricted maximum and minimum values for *DxQual* were visually and computationally confirmed on each response contour and separately for the three intervals of the indexed personality factors displayed within them. For the 47 contours indexing either *EnvStim*, *ProStruc* or *SptGrp* as the situational factor, these were all identified at the limits of the personality and situational factor indices. This coincided with the same finding from the quantitative analysis.

For the *SitStim* response contours, contour maximums and minimums were also identified at the range limits of both the indexed situational and personality factors. However, in contrast to the non-*SitStim* contours, several interval maximums or minimums (never both) were identified between the low and high settings for *SitStim*. The following figure depicts this occurrence in the *Extrav*X*SitStim* (C) perspective.

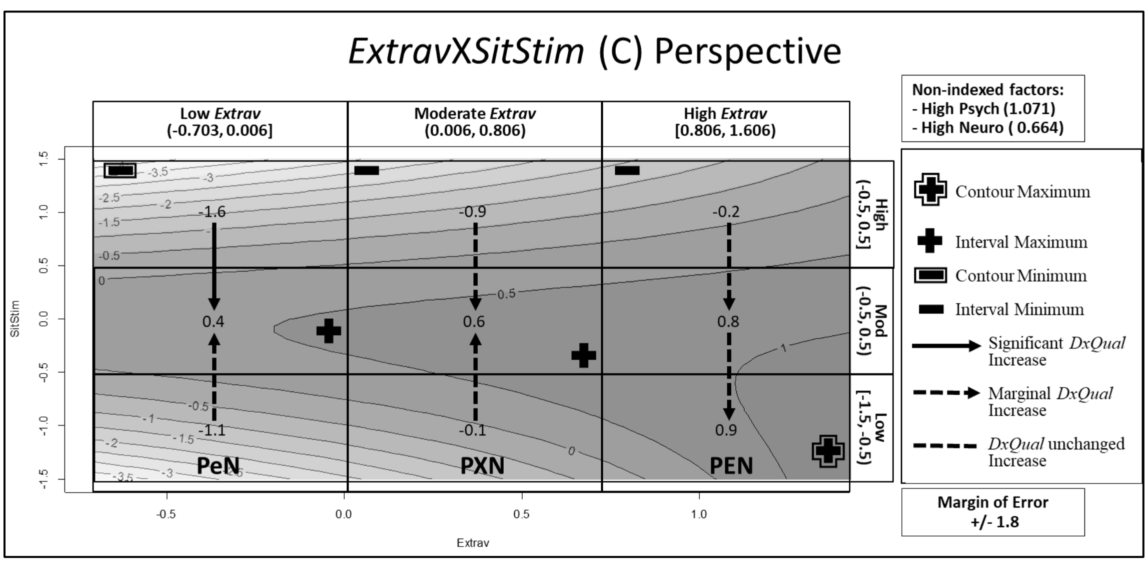

Figure 4.1: *Extrav*X*SitStim* (C) Response Contour

This figure illustrates the deterministic response surface where *SitStim* and *Extrav* are the indexed factors, and *Psych* and *Neuro* are set to high levels. The perspective is sub-divided by the three intervals for the indexed factors, with three personality combination blocks (***PeN***, ***PXN*** and ***PEN***) aligned side-by-side as *Extrav* increases. Range restricted and interval (or block) maximums and minimums are annotated, as well as the estimated slope and direction of change to *DxQual* between the median points of each situational interval in each block. This particular contour perspective demonstrates that unique *DxQual* maxima do exist for any value of *Extrav* for a specifically selected subset of response surface data. In this instance *max(DxQual)* is predicted between the moderate and low levels of *SitStim* across the full range of *Extrav*. Other *SitStim* contours similarly displayed interval maximums and/or minimums between the range limits for *SitStim*.

In fact, unique *DxQual* maxima were identified in the *SitStim* response contours for 11 personality blocks (including the three depicted in Figure 4.1 above). Unique *DxQual* minima were identified in the response contours for 7 personality blocks. Among these, the ***XEN*** block was found with a unique maxima under one set of conditions (non-indexed personality factors set to low) and a unique minima under another (non-indexed personality factors set to high).[157] This demonstrated an inversion of the *Psych:SitStim* interaction as induced by concurrent changes to *Extrav* and *Neuro*.

However, due to the stringent conditionality deriving from *SitStim's* composition as a factor, these specific findings could not be accepted as valid refutations of the contrary findings taken from the non-*SitStim* contours.[158] Nonetheless, they were assessed to be

[157] See the PTA and PTB contours at pages 2 and 3 in the document entitled "*WREM* Response Contours" included as a supplementary file to this report.
[158] Footnote 150 describes *SitStim*'s composition and its limited utility for response surface analysis.

relevant for two reasons. The first was that the *SitStim* response contours did/do provide valid, conditional perspectives of the response surface. The interactions they displayed were/are very real. The second reason was that the *SitStim* response contours represented an emulation of response surface behavior for a non-linear, polynomial prediction equation.[159]

Clearly, this latter point would only matter if future refinements to *WREM* parameters lead to a non-linear prediction equation. On the former point, the specific conditionality of the *SitStim* contours would dictate that findings taken from them would be considered in context. Given these limitations, range restricted maximums and minimums were accepted as a defining characteristic of the *WREM* response surface based on the confirmation provided by the non-*SitStim* conditional response contours.

4.3.2.2 Slope Analysis

Slopes were analyzed on the response contours to obtain estimates for decrements to *DxQual* that would result from any offset of situational factors from the recommended optimal settings.[160] Estimated slopes were established for each optimization rule by examination of relevant contour perspectives and the underlying data. These were appended to the optimization rules as recorded in Appendix I.

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[159] By composing *SitStim* as the cubed root of the product of *EnvStim*, *ProStruc* and *SptGrp* with *EnvStim*=*ProStruc*=*SptGrp*, the regression and prediction equations take on non-linear characteristics.
[160] Steepness was established as the change to *DxQual* over the change to the indexed situational factor. Slopes were estimated at the vertical centerline of personality factor intervals and accepted for use across the entire interval. Slopes greater than 1.0 were classified as very steep. Slopes between 0.9 and 1.7 were classified as steep. Slopes between 0.5 and 0.8 were classified as moderate slopes. Slopes estimated between 0.4 and 0.2 were classified as low slopes. Slopes lower than 0.2 were classified as very low slopes.

Steepness was also considered as a possible predictor of *optimization solution* performance. The response contours indicated very low slopes in 18 of 27 personality blocks for at least one situational factor. Six blocks (***pen***, ***peX***, ***XXX***, ***XXn***, ***peN*** and ***XXN***) depicted low to very low slopes in relation to *EnvStim*, *ProStruc* and *SptGrp*. It was anticipated that this condition would detract from the performance of *optimization solutions* when implemented under uncertainty.

No response contours depicted very steep slopes related to *ProStruc*. However, very steep slopes related to *EnvStim* and *SptGrp* were identified in at least one contour for the ***pEn***, ***Pen***, ***pEX***, ***PeX***, ***pEN***, ***PeN*** and ***PXN*** personality blocks. The ***Pen*** and ***PeN*** blocks had very steep slopes related to both *EnvStim* and *SptGrp*. It was anticipated that this high slope condition would facilitate the performance of *optimization solutions* due to the relative prominence of the conditional *DxQual* maxima as depicted on the response contours. This notion would be further considered by the testing of the *system of situational control* as discussed in Section 4.4.

4.3.2.3 Slope Inversions

Slope inversions are features on the response contours that indicate a sign change to the contour slope caused by changes to the indexed situational factors as plotted against fixed values and/or intervals of the indexed personality factor. The absence of mounds, bowls, stationary ridges and stationary valleys provided additional evidence that there were no localized maxima or minima for any personality combination block within the response surface data (C. Wu & Hamada, 2009; Kutner et al., 2005). In fact, all slope inversions identified in the non-*SitStim* response contours were saddle points. The following figure illustrates a saddle point in the *Psych*X*EnvStim* (A) contour.

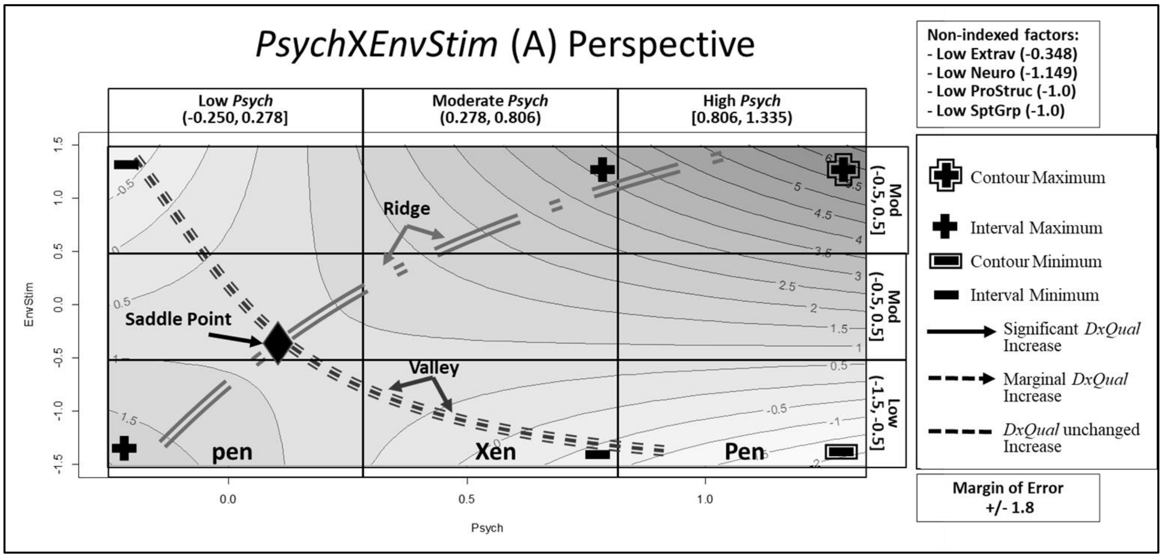

Figure 4.2: Saddle Point in Response Contour *Psych*X*EnvStim* (A)

This contour depicts three adjacent intervals of *Psych* plotted against *EnvStim*. The non-indexed factors include *Extrav*, *Neuro*, *ProStruc* and *SptGrp*, which were set to low. A saddle point is illustrated in the left-most (***pen***) interval of the contour. In the left part of that interval, the contour predicts *max*(*DxQual*) at the lower limit of *EnvStim*. In the right margin of the interval and across the two adjacent intervals (***Xen*** and ***Pen***), the interval and contour maxima occur at the upper limit of *EnvStim*. This saddle point illustrates how the *optimization solution* for the ***pen*** block ($\mathbf{C_L S_H G_L}$) may fail to optimize for *DxQual* due the slope inversion where the indexed *Psych* factor approaches the upper range limit for the interval. The ***pen*** block was also affected by a saddle point in the *Psych*X*SptGrp* (A) conditional response contour.[161]

[161] This is available as the PGA contour on page 34 of the document entitled "*WREM* Response Contours" included as a supplementary file to this report.

Seven personality blocks (***PEn***, ***PEN, pXX***, ***Xen***, ***XEN, XEX*** and ***XXn***) were implicated by similar saddle points related to one situational factor each. Three blocks (***pen***, ***peX*** and ***XXX*****)** were implicated by saddle points related to two situational factors each. In all cases, the reliability of the selected primary *optimization solutions* was confirmed by the location of the saddle points within the affected personality blocks. Additional remarks were added to the implicated optimization rules to call attention to such slope inversions where they were detected. It was anticipated that this would provide cues for consideration of alternate *optimization solutions* in situations where precise personality factor values were known.

The *SitStim* contours provided a different view of the response surface with slope inversions indicated in 9 of 10 *SitStim* contours. These included saddle points, ridges and valleys. However, *SitStim*'s inherent limitations prevented the integration of findings related to these features with those taken from the non-*SitStim* contours. As such, the *SitStim* response contours were excluded from this aspect of the analysis.[162]

4.3.3 Response Surface Analysis Conclusions

Based on the foregoing analysis of slopes and slope inversions, the primary *optimization solutions* were conditionally validated for all 27 personality blocks. The cumulative results of these analyses led to the development of a *system of situational control* for the personality-based optimization of organizationally supported decision making. The following sections describes that system and its evaluation.

4.4 The Proposed *System of Situational Control*

[162] See footnotes 138 and 150.

As indicated previously, primary and alternate *optimization solutions* were established for each of the 27 personality factor combinations from the seven solutions outlined in Table 4.5 above.[163] Slopes were appended to the optimization rules to permit estimation of decrements to *DxQual* that result from deviations from the recommended situational factor settings. Indications of slope inversions were also provided to prompt consideration of alternate rule sets by direct examination of the response surface. The proposed *system of situational control* is provided at Appendix I.

The following table depicts the primary and alternated *optimization solutions* assigned for the ***pen*** personality block.

Table 4.6: *Optimization Solutions* for the *pen* Block

<table>
<tr><th colspan="4">pen</th></tr>
<tr><th colspan="2">Optimization Solutions</th><th>Mean</th><th>Var</th></tr>
<tr><td rowspan="3">Primary</td><td>Set EnvStim to high (</=-1.0)
-0.4 slope//slope inversion</td><td rowspan="3">0.436</td><td rowspan="3">0.447</td></tr>
<tr><td>Set ProStruc to low (>/=1.0)
-0.1 slope</td></tr>
<tr><td>Set SptGrp to low (</=-1.0)
-0.2 slope//slope inversion</td></tr>
<tr><td>Alt 1</td><td>EnvStim mod; ProStruc low; SptGrp low</td><td>0.778</td><td>0.061</td></tr>
<tr><td>Alt 2</td><td>EnvStim low; ProStruc low; SptGrp low</td><td>1.119</td><td>0.168</td></tr>
</table>

Optimization solutions were evaluated in an independent stochastic simulation of the response surface. The results were compared with the original stochastic dataset as a control. The following table depicts summary statistics from that evaluation.

[163] The analysis of *SitStim* response contours led to the development of optimization rules for the *SitStim* factor. However, these provided no specific insights for the optimization of *DxQual* by control of *SitStim's* component subfactors. As such, *SitStim* optimization rules was excluded from this report.

Table 4.7: Summary Statistics for Control vs. Optimized Cases

Stochastic Response Surface Version	*n*	*mean(DxQual)*	*var(DxQual)*	*min(DxQual)*	*max(DxQual)*	Min *Block mean*	Max *Block mean*
Control Case: Full Data	7290K	0.769	0.978	-6.193 ***pEn*** $C_H S_L G_L$	9.466 ***PeX*** $C_H S_H G_L$	0.445 ***pEn***	1.089 ***PeN***
Optimized Case: Data Subset	270K	2.297	1.648	-2.225 ***pen*** $C_H S_L G_L$	9.243 ***PeN*** $C_H S_L G_L$	0.445 ***pen***	4.265 ***PeN***

These results reflected favorably on the application of the proposed system with a 221 percent average increase in *DxQual* at the cost of increased variance. The full comparison of control versus optimized response surface statistics is provided as Table J.1 at Appendix J, which clearly indicates that *DxQual* was positively affected by optimization for all personality factor combinations with the sole exception of the ***pen*** block.

The following table compares the measures of performance for the full set of optimized response surface data and three subsets of that data.

Table 4.8: Comparison of Performance Measures

Stochastic Response Surface Data - Subset Comparison (Percentage Change from Control)				
Optimized Sample Subset	**Change in *mean(DxQual)***	***Change in var(DxQual)***	***Change in max(DxQual)***	***Change in min(DxQual)***
Full Optimized Sample	221%	6%	-1%	-107%
Low Slope Blocks	47%	124%	-3%	-38%
Low Slope/Double Saddle Blocks	34%	107%	-5%	-40%
Very High Slope Blocks	432%	-51%	-3%	-129%

Selected patterns in these results corresponded closely with other patterns identified in the slope analysis, providing some explanation for the ***pen*** block's poor relative performance.

Based on the evaluation of optimization results within and across personality combination blocks, the six low to very low slope personality combination blocks (***pen***,

peX, ***peN, XXn***, ***XXX*** and ***XXN***) previously identified in Section 4.3.2.2 were found to be less facilitated than the full optimized dataset by the application of optimization rules. Three of these blocks (***pen***, ***peX*** and ***XXX*)** were also found to be implicated by saddle points for two out of three situational factors. However, the performance of the subset entitled 'low slope/double saddle blocks' was roughly comparable with the performance of 'low slope blocks' across all indicated performance measures. As such, the difference between these two subsets was assessed to be practically insignificant. In contrast, the seven personality combinations that were previously identified as having very steep slopes (***pEn***, ***Pen***, ***PeN, pEX***, ***PeX***, ***pEN***, ***PeN*** and ***PXN***) all outperformed the full sample in terms of increases to *mean(DxQual)* and *min(DxQual)* and decreases to *var(DxQual).*

These findings led to a conclusion that the slope of factor interactions does affect the performance of *optimization solutions* when modeled under uncertainty. And, while it was left untested, there is an apparent correlation between very high slopes and *DxQual* facilitation by the *optimization solutions*. As for the unique underperformance of the ***pen*** block's *optimization solution*, it seemed sensible to withhold judgment until this sort of optimization failure could be replicated with refined model parameters.[164]

4.5 *Yerkes-Dodson* Effects

Chapter 1, Sections 1.3.2.1 and 1.3.4 established a case for consideration of *EnvStim*, *ProStruc*, *SptGrp* and *SitStim* as possible sources of 'affectivity-as-arousal'. This was motivated by an aim to evaluate their effects on *DxQual* as they might relate to the

[164] The ***pen*** block's primary *optimization solution* was also unique in that it had the highest variance and lowest mean performance among the seven prospective *optimization solutions*.

Yerkes-Dodson law (Wickens & Holland, 2000).[165] A closer look at the *WREM* response surface provided evidence that '*Yerkes-Dodson effects'* might be in play.

When translated to a response surface, the *Yerkes-Dodson law* would be demonstrated by a ridge or a valley in the response contour where a source of cognitive arousal is indexed as a continuous factor and cognitive performance is predicted.[166] In light of this, the saddles and ridges identified in the *SitStim* response contours were further examined as possible evidence of these effects.[167] The figure below provides 3D depictions of the nine *SitStim* contours to illustrate these transitional features.

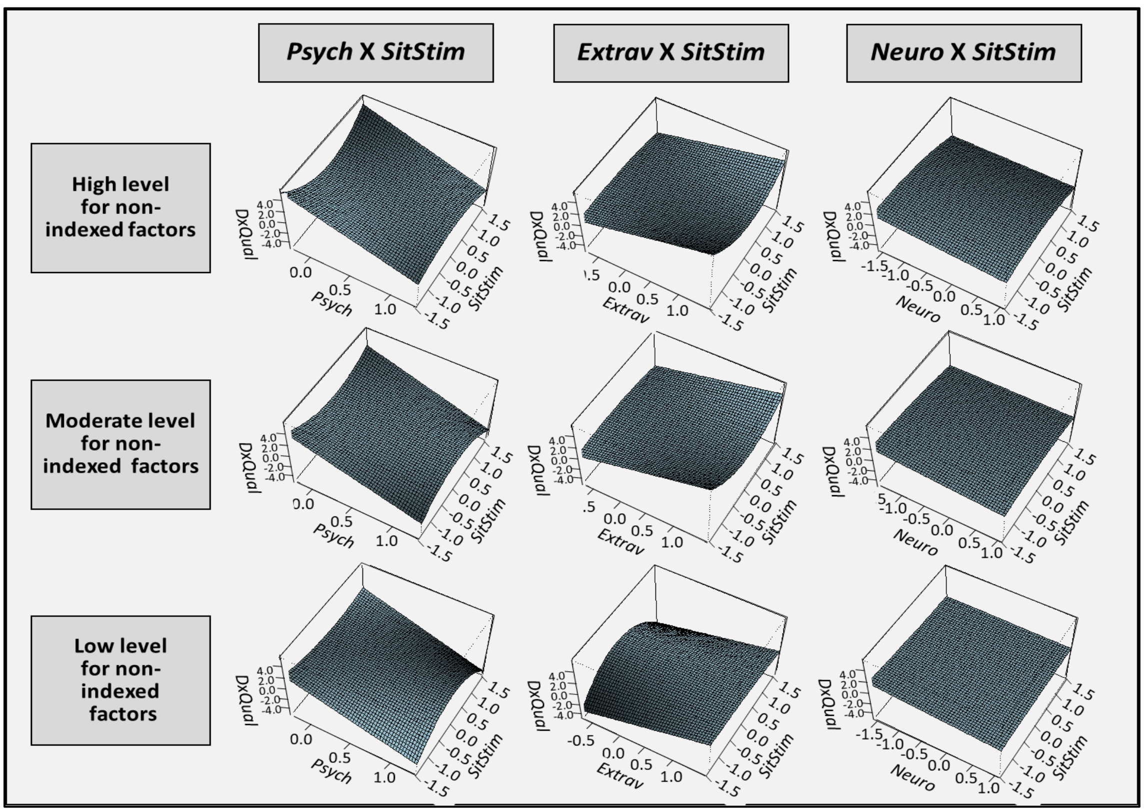

Figure 4.3: *SitStim* 3D Perspectives

[165] See footnote 55.

[166] Response contours depict factor interactions and not main effects. As such, the signs of the component factors will dictate whether the interaction effect is demonstrated as a ridge or a valley.

[167] Significant ridges and valleys were prevalent in the *SitStim* response contours. It was estimated that these may have been caused by multiplicative effects of changes to all three situational factors on *DxQual*.

Each of the nine inset contours illustrate the deterministic response surface where *SitStim* is the indexed situational factor, with *Psych*, *Extrav* and *Neuro* indexed as the personality factor on the left, center and right columns of the figures, respectively. Non-indexed factors were set to high in the upper row of the inset figures, moderate in the middle row and low in the bottom row. Each of these represent the response surface displayed across three adjacent intervals for indexed factors and three adjacent personality combination blocks.

The left-most column depicts valleys that transition to ridges as the indexed personality factor (*Psych*) increases. The axes of these ridges/valleys are perpendicular to the *SitStim* axis and aligned with the *SitStim* axis origin (0). Saddle points mark the inversions from valleys to ridges, which occur in vertical alignment with the *Psych* axis origin (0). All three of these plots depict U-shaped interactions on the left side of the contour, with inverted U-shaped interactions on the right.[168] By consideration of the prediction equation, this inversion is explicable by the sign change of the *Psych* factor as it increases across the origin of its axis (0). However, when the *Psych* factor is re-centered to an exclusively positive range, the inversions are eliminated. Given this, it appears that *Yerkes-Dodson effects* – or something like them – are indicated for the full range of *Psych*.

In contrast with the *Psych* plots, the center column of plots depicts ridges that transition to valleys as *Extrav* increases. These show inverted U-shaped interactions on the left half of *Extrav*'s range and U-shaped interactions on the right. When *Extrav* was re-centered on a positive range, the inversions are eliminated. In this case, *Yerkes-Dodson*

[168] See footnote 20.

effects are possibly indicated as inverted for the full range of *Extrav,* with the inversion induced by the sign difference between the *Extrav and Psych* prediction coefficients.

The three plots on the right side of Figure 4.3 are the *Neuro*X*SitStim* 3D response contours. The two upper plots in this group depict inverted U-shaped interactions across the full range of *Neuro* with no transitions to valleys.[169] As an apparent exception to the eight other plots in this figure, the bottom plot in *Neuro*X*SitStim* column depicts a curving downward slope across the full range of *Neuro* as *SitStim* increases. However, a closer look at this plot on an expanded range demonstrated that even this contour reflects the presence of a ridge, with the crest lying below the established range for *SitStim*. As such, it was assessed that the *Neuro*X*SitStim* provided evidence for *Yerkes-Dodson effects* across the full range of *Neuro,* even without re-centering *Neuro* to a positive range.

Because these contour features provide a basis for inference that *DxQual* maxima may exist within the range limits for selected situational factors, they also suggest that the proposed *system of situational control* is possibly invalid. However, there remain several reasons to wait on forming any conclusions about the implications of the *Yerkes-Dodson law* (Wickens & Holland, 2000) for the current set of *optimization solutions*. Foremost among these reasons is the disconfirmation of these features and transitional phenomena by the non-*SitStim* contours and the response surface data. It is also important to once again

[169] Additional contour plots were prepared on an expanded range for *Neuro*. These similarly failed to predict a transition of the ridge into a valley. The disproportionality of the response surface prediction components provided the explanation for why this transition did not occur. Depending on settings for all predictors, *Neuro*-related prediction components were generally more than an order of magnitude smaller than the sum of all other prediction components. Given this, the sign change to *Neuro* was insufficient to overcome the mass of prediction components and induce an inversion of the response curvature. In sum, *Neuro*'s leverage on the response surface was too small to invert the non-*Neuro*-related effects and interactions.

consider the unique nature of the *SitStim* factor. Nonetheless, if *Yerkes-Dodson effects* were confirmed by further investigation, it is expected that they would provide a simplified logic and robustness to the *system of situational control*. This would be a welcome refinement to *WREM* as a practical system.

4.6 Summary and Conclusions

The results of the *WREM* response surface analysis supported the development and conditional validation of a *system of situational control* for the optimization of decision-making events according to the personality of the decision-maker. This system is comprised of primary and alternate *optimization solutions* with recommended factor settings for each of the three situational factors. These *optimization solutions* also include indications of slope inversions that should inform adjustments to recommended situational factor settings and/or the application of alternate *optimization solutions*.

Deterministic and stochastic simulations supported the generation of the response surfaces and conditional response contours required for evaluation and comparison of optimized solutions against a control. These comparisons revealed dramatic improvements to measures of decision-making performance (e.g., *mean(DxQual)*, *var(DxQual)* and *min(DxQual)*) after optimization rules were applied.

As indicated by the deterministic simulation of the response surface, only three of the 27 combinations of situational factors ($\boldsymbol{C_H S_L G_L}$, $\boldsymbol{C_L S_H G_L}$ and $\boldsymbol{C_L S_L G_L}$) were found to predict *max(DxQual)* within any one personality combination block. Under the uncertainty established by the stochastic simulations, all other combinations of situational factors were found to do so probabilistically for at least one of the 27 personality combinations.

However, only eight were found to do so reliably (i.e., with probability greater than 0.05) and without simultaneously risking the inducement of very poor or wildly variable decision-making performance. Seven of these were ultimately selected as *optimization solutions* based upon their estimated reliability, which collectively accounted for 84.3 percent of the probability mass for obtaining *max(DxQual)* across all personality combination blocks.

SptGrp was found to be the most influential of all factors across the versions and replications of the response surface by anchoring itself at the low factor level for all proposed *optimization solutions*. When established at either moderate or high levels, *SptGrp* predicted *max(DxQual)* less than 7 percent of the time for any personality combination block. As a result, neither 'Moderate *SptGrp*' nor 'High *SptGrp*' were included as part of any primary or alternate *optimization solution*. Of all aspects of the proposed *system of situational control*, this was assessed to be the most constraining.

The magnitude of the slope of changes to *DxQual* on the response contours was found to be a likely predictor of successful optimization. Those blocks with very high slopes dramatically outperformed the full optimized sample by increasing *mean(DxQual)* and *min(DxQual),* while simultaneously decreasing *var(DxQual).* Those blocks with very low slopes dramatically underperformed according to these same measures. This provides a basis for inference that the selection between primary and alternate *optimization solutions* for low-sloping personality blocks may require a closer look at the response surface data.

Findings related to the *SitStim* conditional response contours and the *Yerkes-Dodson law* were of limited value except for what they suggested about response surface dynamics for an alternative version of *WREM*. If the model's predictors are somehow confirmed to have curvilinear relations with *DxQual*, and/or if its three situational factors are combined in to one, then the analysis of *SitStim* and *Yerkes-Dodson effects* are both forward looking and informative. Taken together, the *SitStim* contours and the *Yerkes-Dodson* implications drawn from them would imply a system of simple rubrics in the place of the proposed *system of situational control*: the moderation of all situational factors would be the rule, with discretely identified exceptions. At least for now, this must be rejected.

Future investigators should closely consider the limitations of this analysis. Foremost among these is that the response surface was generated from parameters that are yet to be validated in a realistic context. For these analyses, the *WREM* prediction parameters borrowed from Study 2's mixed-model regression were accepted at face value. However, questions remain in the mind of this researcher about the likelihood of dramatic refinements to *WREM* parameters when it is tested in the context of organizationally supported decision-making events. It must be considered that further refinements to the regression coefficients may lead to important changes to *WREM* factors and their interactions within a refined response surface.

A second limitation arises from the fact that the collection of conditional response contours used to support this analysis represents only a fraction of the available perspectives of the response surface.[170] It cannot be assumed that the implications of unexamined perspectives would be uninformative. Nonetheless, each of the 56 contours

[170] A total of 405 conditional response contours would be required to fully examine a response surface generated by 6 predictors at three levels each.

used in this analysis provided an objectively valid view of the indexed factor interactions that would have been difficult to obtain by quantitative analysis alone.

The final noteworthy limitation of these results is that the primary *optimization solution* failed to facilitate improved performance for one of the 27 personality blocks. According to all relevant measures, the ***pen*** block's performance was actually diminished by the application of the designated *optimization solution* across response surface replications. This highlights the need for caution in applying *optimization solutions* to the very low slope personality blocks. However, if this sort of failure is replicated for any personality block in a refined response surface, this would suggest a closer look at how and why the affected block is contrarily affected by the recommended controls.

This analysis allowed for extensive exploitation of the Study 2 mixed-model regression results. As intended, it delivered a practical *system of situational control* that can be applied to the optimization of decision-making performance according to the personality of the decision maker. However, this system of controls is not offered as a conclusion to this researcher's original line of inquiry. Instead, it is proposed as a framework for further experimentation that concurrently validates and/or refines *WREM*'s parameters and the proposed system of control. In summary, these results suggest that a system of personality-informed situational control can be both practical and effective.

CHAPTER 5. *WREM* IMPLEMENTATION AND CONCLUSIONS

5.1 Introduction

The *War Room Effects Model* (*WREM*) and its accompanying *system of situational control* were developed through the course of field observation, experimentation and response surface analysis. It is estimated the *WREM*'s utility is twofold. By practically and holistically accounting for person and situational factors in an economical theory and model, *WREM* advances our basic understanding of the critically important interactions between these factors and their cumulative effects on decision-making performance. In addition, it is estimated that *WREM* provides the opportunity for the optimization of organizationally supported decisions.

5.2 Summary of Current Research Results

At the onset of this research, the goal was to test a theory that better decisions would result when personality-based preferences of decision makers were accommodated in a military decision-making process. However, by formal observation of 100 war-time decision-making events,[171] it was determined that the observed decisions were fundamentally affected by more than personality and process factors alone. Instead, these events revealed the dynamic interplay between participants, physical and social conditions and the structure of the deliberative processes – all with suspected effects on decision quality. This inspired the redirection of the research objective toward the examination of more-holistic effects on performance and the development of a conceptual model to

[171]See Chapter 1, Section 1.5.1.

account for those effects. Further review of the available literature led to the development of *WREM* as a model of the dynamic interaction between personality and situational factors (i.e., *War Room Effects)*[172] and their implications for cognitive performance.

Two separate experimental studies led to the refinement and conditional validation of *WREM* as a conceptual and parametric model. The first of these examined key factors affecting decision-making in 56 distinct scenarios. This study was conducted through an online survey as an adaptation of *thought experimentation* with 56 repeated measures.[173] It required subjects to evoke (or call to mind) their own concepts for the target events after presentation of stimuli and then to assess the probable outcomes in terms of *Decision Quality*. The results strongly supported a conclusion that all six of *WREM* ‘s independent variables do produce significant main effects on *Decision Quality*.[174] In addition, all six factors were further implicated by significant factor interactions. The concurrent assessment of situational control policies across scenarios also indicated the relative importance of control over the decision-maker’s state and the decision-making process.[175] These results provided support for the acceptance of *WREM* as a theoretic model.

Study 2 focused on the evaluation of interactions between *WREM*’s independent variables and the further development of *WREM* as a parametric model. Seven distinct decision-making scenarios were examined through a similar process of *thought experimentation*, where subjects were required to complete assessments of *Decision Quality* for up to seven scenarios, with each scenario comprised of multiple runs. Seven

[172] *War Room Effects* are introduced in Section 1.1 of Chapter 1 as the dynamic interaction of personality attributes and situational conditions as they affect cognitive performance.
[173] See footnote 43.
[174] See Chapter 2, Section 2.7.
[175] See Chapter 2, Section 2.8.

factor interactions were found to be either highly significant or implicated by higher-order interactions with substantial mediation of the predictors' main effects.[176] An adaptation of the *policy-capturing* technique[177] was also included in this study to obtain subject assessments for the utility of specific situational controls for each experimental run. These 'control policy assessments' provided further support for acceptance of all three situational factors and two of three personality factors as core factors in *WREM*.[178] In addition, they provided reinforcing evidence of one-to-one relationships between personality and situational factors that were not indicated by the experimental results themselves. Overall, this study supported acceptance of *WREM* as a parametric model and reinforced the prior notion that personality and situational factor interactions were key predictors of *Decision Quality*.

The cumulative results of these two studies were taken together as the conditional validation of *WREM* as a personality-informed theory of human performance. The resulting parametric model also allowed for the generation of response surfaces for the representation of *Decision Quality* across variable settings and constraints for *WREM*'s independent variables.

As the final research activity, response surface analysis permitted the identification and evaluation of unique *optimization solutions* for 27 personality blocks comprised of the full-factorial combinations of *PEN model* factors (H. Eysenck, 1998) at three levels each. Response surfaces were generated by parameters derived from the regression analysis of

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[176] See Chapter 3, Section 3.6.2.
[177] See footnote 55.
[178] See Chapter 3, Section 3.6.3.

Study 2 data. A deterministic version of the response surface supported the identification of the specific situational factor combinations that would maximize *Decision Quality* for each personality block. Stochastic versions of the response surface provided estimates for the reliability of each combination as a prospective *optimization solution* when exposed to random variation of the independent variables. These findings were confirmed by examination of conditional response contours and accepted as the basis for selection of *optimization solutions,* with one primary and two alternate solutions for each personality block. Together, with additional details obtained from the response contours, these were established as a *system of situational control*.[179]

When applied to the generation of a new set of response surfaces, this *system of situational control* produced dramatic improvements to average *Decision Quality* for 26 of the 27 personality blocks, with similarly dramatic increases to minimum *Decision Quality*.[180] Pending *WREM*'s validation in a more realistic context, these results demonstrated the general effectiveness of the *system of situational control.*

5.3 Key Limitations of Current Research

Several limitations have been discussed throughout the chapters of this report. Three of these deserve highlighting in the context of this report's conclusions, while the others bear consideration in the context of any further investigations of *WREM*.

The first key limitation is that *WREM*'s parameters and the *system of situational control* were developed by extrapolation from experimental data obtained from *thought*

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[179] See Section 4.4 of Chapter 4.

[180] See Table I.1 of Appendix I. In the case of one personality block (the 'low *Psychoticism*/low *Extraversion*/low *Neuroticism* block), the implementation of the primary *optimization solution* resulted in a marginal decrease to average *Decision Quality.*

experiments.[181] The second is that these data derived from an imbalanced sampling of the experimental design space and by use of subject samples that were highly skewed for age, experience and gender.[182] Considered together, these limitations support a conclusion that *WREM* has only been conditionally validated.

The third key limitation is that the *Intelligence, Experience* and *Decision Typology* factors were each examined only at control settings. As stated repeatedly throughout this report, these should be expected to moderate and/or mediate *War Room Effects.* As such, the *WREM*'s generalizability will remain limited until these and other unattended *WREM* factors are more thoroughly considered.

5.4 Expanding *WREM*'s Horizons

WREM presents clear opportunities for further research and for direct application to industrial/organizational decision making. The following section outlines these opportunities separately.

5.4.1 Future Research Opportunities

Despite that this research has driven toward the delivery of a practical decision-support concept, the results also contribute to our basic understanding of human performance. Unresolved questions have been identified throughout the chapters of this report, with others arising from broader consideration of the results. The following sections outline these as possible opportunities for basic and applied research related to the refinement and/or implementation of *WREM.*

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[181] See Footnote 43.

[182] See Sections 2.4.2 and 2.7.1 of Chapter 2 and Sections 3.4.2 and 3.6.1 of Chapter 3.

5.4.1.1 Basic Research Opportunities

Beyond the validation of the model, future basic research might be usefully directed toward expanding on *WREM*'s explanatory power by the refinement and validation of its heretofore unexamined factors. For instance, it has been considered that the *Affective State* or *Cognitive Processing Strategy* factors might eventually be confirmed to mediate the effects of *WREM*'s core independent variables. These two factors were established in Section 1.4.1 of Chapter 1 as the direct antecedents of the *Cognitive Performance* factor. However, if either factor were found to be an effective bottleneck between *WREM*'s personality/situational effects and *Cognitive Performance*, this would possibly suggest the need for reconceptualization of the entire model. Beyond these two factors, there has also been no effort to confirm the roles of *Emergent Attributes* and *External Factors*.

Possible research questions related to these four theoretic factors include:

- To what degree does *Affective State* mediate previously identified personality effects and interactions on *Cognitive Processing Strategy*, *Cognitive Performance* and *Decision Effectiveness*?

- What are the effects of *Emergent Attributes* on *Cognitive Performance*, and to what degree are these effects mediated by the *Affective State* of the decision maker?

- What are the effects of *External Factors* on *Cognitive Performance*, and to what degree are these effects mediated by the *Affective State* of the decision maker?

The original rationale for the inclusion of these four factors remains intact. However, questions remain about whether their inclusion can be justified by evidence of effects on decision making and whether they must be maintained separately from other factors. Notwithstanding these questions, they cannot be assumed to be irrelevant or subsumed by other *WREM* factors.[183]

As for the *Intelligence* and *Experience* factors, these have been employed only at control settings for Studies 1 and 2. Nonetheless, it was previously identified that both factors should be expected to produce significant effects on *WREM*'s *Cognitive Performance* factor (Landy & Conte, 2010; Behling, 1998; Osman, 2008; Ilkowska, 2011).[184] This alone indicates their value as concomitant variables in the post-hoc evaluation of decision making results. However, Section 1.4.2.2 of Chapter 1 also highlights the relationships between these factors and selected components of the *Affect Infusion Model* (Forgas, 1995) and *Situational Strength* (Meyer et al., 2009; Meyer, Kelly & Bowling, 2017) as well as their associations with learning and skill acquisition (Landy and Conte, 2010). These associations provide a basis for inference that their main effects might be moderated and/or mediated by *WREM*'s personality and situational factors with significant implications for model parameters.

Possible questions related to the *Intelligence* and *Experience* factors include:

- What are the effects of *Intelligence* and *Experience* on *Affective State, Cognitive Performance* and *Decision Effectiveness?*

- To what degree are these effects moderated/mediated by *WREM*'s personality and situational factors and interactions?

Depending on the practical significance of factor interactions involving *Intelligence* and/or *Experience*, and their possible mediation by other *WREM* components, it may be that a new approach to optimization may be required for the *system of situational control*.

[183] See Chapter 1, Section 1.4.1 for the original rationale applied to the inclusion of these factors.
[184] See Section 1.4.2.2 of Chapter 1.

As a final subject for further basic research, it might be considered whether the inclusion *WREM* components drawn from *AIM* (Forgas, 1995, 2017) and *Situational Strength* (Meyer et al., 2009; Meyer, Kelly & Bowling, 2017) have been combined and integrated in a manner that best employs these concepts' potential for explaining variance in behavior and performance.[185]

5.4.1.2 Applied Research Opportunities

Apart from *WREM*'s value as the subject of basic research, it is also ripe for further study as an applied subject where it might be established as a viable decision-support concept. Assuming that such research leads to the model's further validation, it could then be considered for verification through implementation.

In the first order, this should be undertaken through non-intrusive studies to confirm the accessibility, validity and utility of measures for *WREM*'s core factors and to obtain real-world evidence of cause-and-effect relationships between them. The participation of relevant organizations would best assure the success of this endeavour. However, the solicitation of their participation may depend, in part, on their acceptance of a basic concept for *WREM*'s implementation. As such, the following section briefly describes key aspects of an implementation concept.

5.4.2 WREM Implementation

WREM implementation is the set of activities that lead to the adoption of a verified *system of situational control* by relevant organizations. These are envisaged as follows:

[185] See footnote 28.

- Establishing a *community of interest.*
- Establishing accessible, suitable and valid measures for *WREM*'s core factors.
- Establishing roles and responsibilities for the application of *WREM's system of situational control.*
- Applying the *system of situational control* to decision making events.
- Assessing the results and adapting measures, roles and responsibilities.

The following sections discuss each of these as implementation requirements.

5.4.2.1 A *Community of Interest*

Beyond the obvious value of their support to applied research, relevant organizations would be required as active participants in *WREM* implementation. As a *community of interest*, these organizations would provide the necessary access to realistic testing conditions and the expert insights needed to ensure that *WREM*'s validation would lead to the delivery of practical concepts.

Development of the *community of interest* will require a recruitment effort that is guided by the nature of each prospective organization's engagement with decision making. Does the organization experience a regular demand for making critical decisions? Does it approach the management of decision-making events and processes systematically? Does it place value on the quality of the decisions delivered through these events and processes? Is there diversity among the organization's decision makers? Is the culture amenable to active control over decision making? For viable members in the *community of interest*, these questions would be answered in the affirmative.

However, it is also anticipated that few organizations will risk exposing their decision makers and decision-making processes to an unproven concept. As such, recruitment for the initial *community of interest* must prioritize organizations who also have a demonstrable interest in developing new solutions for decision-making performance and will underwrite the inherent costs and risks of implementation.

Given these considerations, high-level military organizations would be excellent prospects for early membership. Other lucrative prospects would include large, hierarchical organizations, which are engaged in the security, crisis response/management, public relations, marketing, acquisitions and finance sectors, and possessed with an active interest in the improvement of their business processes.

5.4.2.2 Measures for *WREM*'s Core Factors

WREM implementation will require the adoption of real-world measures for the model's core factors. To date, *WREM*'s independent variables have only been employed as factors by stimuli representations, which were not composed with any specific consideration for their measurement in the real world. In addition, *WREM*'s response variables have only been applied as subjective assessments of *Decision Quality*, and then only in the mind of individual experimental subjects.

For some factors, this will demand the development and validation of altogether new measures. For others, these may be drawn from authoritative sources and judiciously adapted to support the application of the *system of situational control*. However, it will be necessary to establish measures that can be consistently applied across decision making events and organizations.

WREM's established factors, subfactors and signal characteristics already provide a framework for the required suite of measures. In addition, the definitions at Section 1.2.3 of Chapter 1 provide the concepts against which each measure's validity should be tested. However, the translation of these factors into measures should be undertaken with regard for the theoretical underpinnings of *WREM* as addressed in Sections 1.3 and 1.4 of Chapter 1. Literature related to the *Yerkes-Dodson law* (Wickens & Holland, 2000; Hanoch & Vitouch, 2004; De Dreu, Baas & Nijstad, 2008), the *Vroom-Yetton model* (Vroom & Jago, 1988, 2007; Vroom & Yetton, 1973), *AIM* (Forgas, 1995, 2001, 2002, 2017; Forgas, Johnson & Ciarrochi, 1999) and *Situational Strength* (Meyer et al., 2009; Cooper & Withey, 2009; Meyer et al.2010; Meyer, Kelly & Bowling, 2017) also deserve close consideration as sources of inspiration for *WREM*'s subfactors and subordinate attributes.

For personality factors, this can be accomplished in straightforward fashion by adoption of the well-established measures for the *PEN model* (H. Eysenck & S. Eysenck, 1975; H. Eysenck, 1998; H. Eysenck & Wilson, 1991; Francis & Jackson, 2004).[186] Measures for the *Intelligence* and *Experience* might also be drawn from authoritative sources, as long as they are maintained as orthogonal concepts among *WREM*'s *Person Factors.* Because both factors are seen as likely sources of performance variance, these should be adapted in ways that will maximize their utility as concomitant variables for post-hoc analysis.[187]

With respect to *WREM*'s core situational factors, the development of measures may

[186] Alternative personality measures might be adopted or adapted insofar as these can be validly correlated as proxies for the *PEN model*'s three super-factors. See McCrae and Costa (1985a) for discussion of the relationship between *PEN model* super-factors and *FFM* factors.
[187] See Section 1.4.2.2 of Chapter 1.

be less straightforward. The definitions established for the *Environmental Stimulation, Process Structure* and *Support Group* factors[188] permitted the robust representation of situational conditions. However, these factors were only established as composites of their subfactor descriptors.[189] It was not considered how practical measures might be gleaned from the related literature and/or other authoritative sources and then combined to form valid measures of the parent factors. Nonetheless, the source literature for the subfactors, signal characteristics and component attributes should provide a start-point for this effort.

Problem classification measures may be adapted from the characteristics of the *Decision Typology* factor as described at Section 1.4.2.3 of Chapter 1. Beyond their significance to the parametric model, these measures are also required to support an organization's determination of *WREM* applicability to specific decision-making events. As with the core situational factors, the source literature for the *Yerkes-Dodson law*, the *Vroom-Yetton model* and *AIM* may be relevant.

Cognitive Performance and *Decision Effectiveness* are potentially less problematic. As recorded in Sections 1.2.3 and 1.4.1 of Chapter 1, the definitions for these response variables can be directly applied as subjective measures. However, it would be necessary to move beyond these to obtain measures that reflect objective appraisals that can be comparably applied across organizations and decision-making events. Reflecting on the differences identified between the response variables for the *Yerkes-Dodson law* (Wickens & Holland, 2000; Hanoch & Vitouch, 2004), the *Vroom-Yetton model* (Vroom & Yetton, 1973; Vroom & Jago, 1988), *AIM* (Forgas, 1995, 2017) and *Situational Strength* (Meyer

[188] See Section 1.4.2.3 of Chapter 1.
[189] See Sections 2.2 and 2.5 of Chapter 2 and Section 3.2 of Chapter 3.

et al., 2009; Meyer, Kelly & Bowling, 2017),[190] it should not be difficult to settle on viable concepts for the measurement of these two factors.

Once developed, these measures must be validated and verified through observational studies to confirm the accessibility, suitability and sufficiency of measurements and measurement protocols. This would best occur in the context of organizational decision-making events with the active participation of *WREM*'s *community of interest*.

5.4.2.3 Roles and Responsibilities

Defined roles and responsibilities are also required to support *WREM* implementation and the application of the *system of situational control*. Key among these are roles and/or responsibilities related to:

- The classification of problems for decision.
- The determination of *WREM* applicability for specific decision-making events.
- The designation of decision makers.
- The facilitation of selected situational controls.
- The post hoc assessment of the delivered decisions.

Organizational and individual roles and responsibilities should be separately defined. And, while the primary roles and responsibilities may lie at the organizational level, it is foreseen that these may be appropriately delegated to decision makers themselves. At a minimum,

[190] See Section 1.4.1 of Chapter 1.

the decision makers should be vested with responsibility to support the assessment and selection of *optimization solutions*, the facilitation of the situational controls and the assessment of results.

5.4.2.4 Application of the *System of Situational Control*

After the establishment of organizational measures, roles and responsibilities, it is estimated that *WREM*'s *system of situational control* could be applied as follows:

- *Step 1: Classify emergent problems as decisions and determine the applicability of WREM.* This would be based upon how the problem and associated decision-making processes are estimated to conform to the established classification measures as indicators of the utility for explicit control over situational conditions.

- *Step 2: Identify constraints on the use of situational controls.* This would account for externally and internally imposed or otherwise unavoidable conditions that may delimit the options for control over certain situational conditions of a decision-making event. Constraints may prevent selection of certain *optimization solutions* or impose the requirement for selection of a unique *optimization solution*.

- *Step 3: Designate a qualified decision maker*. This process establishes a single individual with the authority and responsibility to decide on behalf of the organization. This designation may occur as a matter of course based on the nature of the underlying problem or other organizational concepts and norms. It might also occur more deliberately through the organization's identification of an individual who is well-suited for deciding under exposure to known situational constraints. On the other hand, the designation might also be arbitrary. In any case, the designee's measured personality would provide the primary rationale for selection of an *optimization solution*.

- *Step 4: Assess and select optimization solutions according to the measured personality of the designated decision maker.* This may occur by direct consideration of *WREM*'s primary and alternate *optimization solutions* or by selection of a unique *optimization solution* as indicated by the *WREM* response surface. This assessment and selection process might also include consideration for offsets from established *optimization solutions* based on situational constraints, decision-maker preferences or both. However, the selection of any unique *optimization solution* would imply acceptance of estimated performance decrements that result from offsets on one or more situational conditions.

- *Step 5: Support imposition and maintenance of situational controls.* This would include all efforts by the organization and/or the designated decision maker to facilitate the selected *optimization solution*. It might also include the organization's application of other decision-support resources or the imposition of decision-making processes.

- *Step 6: Monitor the decision-making event and assess outcomes.* This would include monitoring for deviations from the selected *optimization solution*. It would also include monitoring for emergent and external dynamics that support the objective evaluation of the decision and post-implementation outcomes.

5.4.2.5 Assessment of Results and Adaptation of Measures

Following application of the *system of situational control*, it is anticipated that refinements may be required to the *WREM implementation concept* and the model's parameters. This suggests the need for standardized approaches to post-hoc assessment and for the analysis of *WREM* efficacy across events, contexts and organizations. The development of such standardized approaches should occur in stride with the conduct of studies undertaken to validate and verify measures and the *system of situational control*.

5.5 Research Conclusions

This report began by comparing and contrasting the head-to-head decisions made by Robert E. Lee and George G. Meade on the eve of Gettysburg's culminating battle. We were informed that both generals were confronted by similarly critical problems, both were comparably qualified to make the required decisions, and both had authority over how they would control their decision-making events to ensure the best possible outcomes. We also learned that the personalities of the two commanders were very different and that only Meade – for unknown reasons – opted for control over how he made his decision.

The results of the next-day's battle vindicated Meade's choice for control. On the other hand, Lee's neglect of the opportunity for control followed-on quickly to a poor decision, a cataclysmic defeat, and the beginning of the end for the Confederate cause. Thus, by evidence of history, the manner of Meade's decision making was effective. Lee's was not.

There was no science to support either general's decision for or against control over their decision-making circumstances. Neither can science reasonably support any inferences about the cause-and-effect relationships between the decision-making conditions, the commanders' judgments and the combat outcomes. Nonetheless, these vignettes are useful illustrations of a gap that existed in the art and science of 19th century command, which persists until today among the decision and management-related sciences. There were and are no accepted rules, systems, models or theories that inform the control selections for organizationally supported decision-making events that will account for the predictable effects of personality on a decision.

WREM proposes to remove this gap by providing a fulsome explanation for how holistically represented persons and situations interact to affect cognitive performance and post-implementation outcomes. Its core factors and interactions have been conditionally validated by use of *thought experimentation* and *policy-capturing*. Its parameters have been applied to the generation of response surfaces that allowed for the identification of *optimization solutions* and the development and analysis of a personality-based *system of situational control.* That system has been demonstrated by stochastic simulation to predict significant improvements to decision-making performance. And finally, the *WREM* *implementation concept* illustrates how *WREM* and its *system of situational control* might be applied to actual organizations and decisions.

Other novelties delivered by this body of research include:

- *Trait dimensional scales* for selected personality traits that are aligned with the *PEN model*'s super-factors (see Section 2.5.1 of Chapter 2).
- A random/fixed-factor (hybrid) approach to experimental design (see Section 3.4.1 of Chapter 3).
- A stochastic simulation of an experimental survey (see Section 3.4.3 of Chapter 3).

This body of research constitutes a systematic, theoretic approach to judgment and decision-making research with emphasis on factor interactions. Once validated, it is anticipated that *WREM* will afford opportunities for personality to be considered alongside intelligence, experience and other individual differences as a key performance indicator. Its straightforward composition provides testable explanations for the cause-and-effect relationships between its component factors, their interactions and the products of complex decision making.

Consistent with the research objectives, *WREM* directly supports the optimization of organizationally supported decision making according to the personality of a designated decision maker. Subject to further validation, it will allow organizations to take fuller advantage of each person's decision-making potential by accounting for and systematically accommodating their personality-based individual differences through application of *WREM*'s *system of situational control*. More importantly, *WREM* uniquely highlights personalities and their interactions with situational factors as indispensable components in any adequate model of decision-making performance.

APPENDIX A: STUDY 1 EXPERIMENTAL DESIGN MATRICES

Tables A.1 and A.2 provide the experimental design matrices for Version A and Version B of the survey.

Table A.1: Study 1 Experimental Design Matrix (Version A)

Version A Run #	Personality Factors				*EnvStim* Factor Level	*ProStruc* Factor Level	*SptGrp* Factor Level
	Personality Combination	*Extrav* Factor Level	*Neuro* Factor Level	*Psych* Factor Level			
1	eXX+	0	1	1	0	0	0
2	XnX-	1	0	1	0	0	0
3	XXp+	1	1	0	0	0	0
4	XXX-	1	1	1	0	0	0
5	XXP+	1	1	2	0	0	0
6	XNX-	1	2	1	0	0	0
7	EXX+	2	1	1	0	0	0
8	eXX-	0	1	1	0	0	1
9	XnX+	1	0	1	0	0	1
10	XXp-	1	1	0	0	0	1
11	XXX+	1	1	1	0	0	1
12	XXP-	1	1	2	0	0	1
13	XNX+	1	2	1	0	0	1
14	EXX-	2	1	1	0	0	1
15	eXX+	0	1	1	0	1	0
16	XnX-	1	0	1	0	1	0
17	XXp+	1	1	0	0	1	0
18	XXX-	1	1	1	0	1	0
19	XXP+	1	1	2	0	1	0
20	XNX-	1	2	1	0	1	0
21	EXX+	2	1	1	0	1	0
22	eXX-	0	1	1	0	1	1
23	XnX+	1	0	1	0	1	1
24	XXp-	1	1	0	0	1	1
25	XXX+	1	1	1	0	1	1
26	XXP-	1	1	2	0	1	1
27	XNX+	1	2	1	0	1	1
28	EXX-	2	1	1	0	1	1
29	eXX+	0	1	1	1	0	0
30	XnX-	1	0	1	1	0	0
31	XXp+	1	1	0	1	0	0
32	XXX-	1	1	1	1	0	0
33	XXP+	1	1	2	1	0	0
34	XNX-	1	2	1	1	0	0
35	EXX+	2	1	1	1	0	0
36	eXX-	0	1	1	1	0	1
37	XnX+	1	0	1	1	0	1
38	XXp-	1	1	0	1	0	1
39	XXX+	1	1	1	1	0	1
40	XXP-	1	1	2	1	0	1
41	XNX+	1	2	1	1	0	1
42	EXX-	2	1	1	1	0	1
43	eXX+	0	1	1	1	1	0
44	XnX-	1	0	1	1	1	0
45	XXp+	1	1	0	1	1	0
46	XXX-	1	1	1	1	1	0
47	XXP+	1	1	2	1	1	0

Version A Run #	Personality Factors				*EnvStim* Factor Level	*ProStruc* Factor Level	*SptGrp* Factor Level
	Personality Combination	*Extrav* Factor Level	*Neuro* Factor Level	*Psych* Factor Level			
48	XNX-	1	2	1	1	1	0
49	EXX+	2	1	1	1	1	0
50	eXX-	0	1	1	1	1	1
51	XnX+	1	0	1	1	1	1
52	XXp-	1	1	0	1	1	1
53	XXX+	1	1	1	1	1	1
54	XXP-	1	1	2	1	1	1
55	XNX+	1	2	1	1	1	1
56	EXX-	2	1	1	1	1	1

The three letter annotation for personality combination labels includes ‘p’, ‘X’ or ‘P’ for the low, moderate or high setting of *Psych,* ‘e’, ‘X’ or ‘E’ for the low, moderate or high setting of *Extrav* and ‘n’, ‘X’ and ‘N’ for the low, moderate or high setting of *Neuro*.

The ‘+’ and ‘-’ symbols indicate whether the run is supported by ‘more likable’ (+) or ‘less likable’ (-) descriptor groups.

Table A.2: Study 1 Experimental Design Matrix (Version B)

Version B Run #	Personality Factors				*EnvStim* Factor Level	ProStruc Factor Level	*SptGrp* Factor Level
	Personality Combination	*Extrav* Factor Level	*Neuro* Factor Level	*Psych* Factor Level			
1	eXX-	0	1	1	0	0	0
2	XnX+	1	0	1	0	0	0
3	XXp-	1	1	0	0	0	0
4	XXX+	1	1	1	0	0	0
5	XXP-	1	1	2	0	0	0
6	XNX+	1	2	1	0	0	0
7	EXX-	2	1	1	0	0	0
8	eXX+	0	1	1	0	0	1
9	XnX-	1	0	1	0	0	1
10	XXp+	1	1	0	0	0	1
11	XXX-	1	1	1	0	0	1
12	XXP+	1	1	2	0	0	1
13	XNX-	1	2	1	0	0	1
14	EXX+	2	1	1	0	0	1
15	eXX-	0	1	1	0	1	0
16	XnX+	1	0	1	0	1	0
17	XXp-	1	1	0	0	1	0
18	XXX+	1	1	1	0	1	0
19	XXP-	1	1	2	0	1	0
20	XNX+	1	2	1	0	1	0
21	EXX-	2	1	1	0	1	0
22	eXX+	0	1	1	0	1	1
23	XnX-	1	0	1	0	1	1
24	XXp+	1	1	0	0	1	1
25	XXX-	1	1	1	0	1	1
26	XXP+	1	1	2	0	1	1
27	XNX-	1	2	1	0	1	1
28	EXX+	2	1	1	0	1	1
29	eXX-	0	1	1	1	0	0
30	XnX+	1	0	1	1	0	0
31	XXp-	1	1	0	1	0	0
32	XXX+	1	1	1	1	0	0
33	XXP-	1	1	2	1	0	0
34	XNX+	1	2	1	1	0	0
35	EXX-	2	1	1	1	0	0
36	eXX+	0	1	1	1	0	1
37	XnX-	1	0	1	1	0	1
38	XXp+	1	1	0	1	0	1
39	XXX-	1	1	1	1	0	1
40	XXP+	1	1	2	1	0	1
41	XNX-	1	2	1	1	0	1
42	EXX+	2	1	1	1	0	1
43	eXX-	0	1	1	1	1	0
44	XnX+	1	0	1	1	1	0
45	XXp-	1	1	0	1	1	0
46	XXX+	1	1	1	1	1	0
47	XXP-	1	1	2	1	1	0
48	XNX+	1	2	1	1	1	0
49	EXX-	2	1	1	1	1	0
50	eXX+	0	1	1	1	1	1

Version B Run #	Personality Factors				*EnvStim* Factor Level	ProStruc Factor Level	*SptGrp* Factor Level
	Personality Combination	*Extrav* Factor Level	*Neuro* Factor Level	*Psych* Factor Level			
51	XnX-	1	0	1	1	1	1
52	XXp+	1	1	0	1	1	1
53	XXX-	1	1	1	1	1	1
54	XXP+	1	1	2	1	1	1
55	XNX-	1	2	1	1	1	1
56	EXX+	2	1	1	1	1	1

The three letter annotation for personality combination labels includes ‘p’, ‘X’ or ‘P’ for the low, moderate or high setting of *Psych,* ‘e’, ‘X’ or ‘E’ for the low, moderate or high setting of *Extrav* and ‘n’, ‘X’ and ‘N’ for the low, moderate or high setting of *Neuro*.

The ‘+’ and ‘-’ symbols indicate whether the run is supported by ‘more likable’ (+) or ‘less likable’ (-) descriptor groups.

APPENDIX B: STUDY 1 DESCRIPTORS

Tables B.1, B.2 and B.3 provide the personality, situational and control factor descriptors selected for use in stimuli development for Study 1.

Table B.1: Study 1 Personality Factor Descriptor Groups

FACTOR LEVEL			LIKABILITY	PERSONALITY DESCRIPTOR GROUP
Extraversion	*Neuroticism*	*Psychoticism*		
Low	Moderate	Moderate	+	(shy / accommodating) / (sensitive / emotional) / (original / reasonable)
			-	(very shy / timid) / (anxious / emotional) / (creative / considerate)
Moderate	Low	Moderate	+	(sociable / cooperative) / (calm / stable) / (original / reasonable)
			-	(approachable / assertive) / (very relaxed / unemotional) / (creative / considerate)
Moderate	Moderate	Low	+	(sociable / cooperative) / (sensitive / emotional) / (unimaginative / agreeable)
			-	(approachable / assertive) / (anxious / emotional) / (unoriginal[191])
Moderate	Moderate	Moderate	+	(sociable / cooperative) / (sensitive / emotional) / (original / reasonable)
			-	(approachable / assertive) / (anxious / emotional) / (creative / considerate)
Moderate	Moderate	High	+	(sociable / cooperative) / (sensitive / emotional) / (very creative / tough minded)
			-	(approachable / assertive) / (anxious / emotional) / (innovative / stubborn)
Moderate	High	Moderate	+	(sociable / cooperative) / (nervous / passionate) / (original / reasonable)
			-	(approachable / assertive) / (tense / moody) / (creative / considerate)
High	Moderate	Moderate	+	(outgoing / demanding) / (sensitive / emotional) / (original / reasonable)
			-	(very forward / dominant) / (anxious / emotional) / (creative / considerate)

[191] 'Submissive' was omitted from this stimuli group due to its contradiction with 'assertive'. It was foreseen that if these terms were employed together within the same stimuli, this might impact on subjects' ability to associate effective decision-making with persons so described. Study 2 would retain these contradictory terms in one of its seven run variants based on an expectation that the more-robust stimuli would better enable subjects to process effective decision-maker percepts, despite this contradiction.

Table B.2: Situational Factors Descriptors

SITUATIONAL DESCRIPTORS					
SITUATIONAL FACTOR	**LEVEL**	**SIGNAL CHARACTERISTIC / DESCRIPTOR**			
		Auditory	**Visual**	**Haptic / Other**	
Environmental Stimulation (EnvStim)	High	loud	Dazzling	bustling	
	Moderate	even-toned	well lit	settled	
	Low	muffled	Dim	soothing	
		Logic	**Rigor**	**Clarity**	
Process Structure (ProStruc)	High	rational / deductive / methodological	meticulous	doctrinal	
	Moderate	sensible / informed / progressive	Flexible	common practice	
	Low	intuitive/ inductive / recursive	relaxed	improvised	
		Subordinate Information	**Goal Congruence**	**Subordinate Conflict**	**Social Composition**
Support Group (SptGrp)	High	partially informed	goal-divergent	competitive	large / unfamiliar / high-spirited
	Moderate	**not used**	**not used**	**not used**	**not used**
	Low	comprehensively informed	goal-congruent	agreeable	small / well-acquainted / collegial

Descriptor groups can be identified by combining vertically aligned descriptors across the 'signal characteristics/descriptor' columns in the table above.

Table B.3: Control Factor Descriptors

Factor	Signal Characteristic	Descriptor(s)	Rationale for Inclusion
Intelligence	None	highly intelligent	to prevent subject inferences of lesser or inadequate intelligence by association with personality descriptors
Experience	None	experienced	to prevent subject inferences of low experience or inadequacy for the decision-making task by association with decision typology descriptors
Conscientiousness	None	conscientious	to prevent subject inferences of low conscientiousness or motivation by association with personality descriptors
Decision Typology	**Urgency**	urgent	to reinforce the necessity of arriving at a decision during the course of the represented event
	Complexity	highly complex	to reinforce the necessity of effortful and deliberative cognitive processing on the part of the represented decision maker
	Novelty / Typicality	novel / atypical	to reinforce the necessity of effortful and deliberative cognitive processing on the part of the represented decision maker
	Criticality	highly critical	to reinforce the importance of decision quality
	Certainty / Ambiguity	uncertain / ambiguous	to provide for maximum variability in decision quality across experimental scenarios

APPENDIX C: STUDY 1 MIXED-MODEL REGRESSION RESULTS

These analyses are performed in R using lmer and r.squaredGLMM functions. These functions require the lme4; MuMIn packages.

Factor labels are as follows for this analysis:

DxQual - *DxEffect*
Subject - *Subject*
Version - *Version*
Psycho - *Psych*
Extrav- *Extrav*
Neuro - *Neuro*
EnvStim - *EnvStim*
ProStruc - *ProStruc*
SocComp - *SptGrp*

See Section 2.2 of Chapter 2 for factor definitions.

Linear mixed model fit by REML ['lmerMod']

```
Formula: (DxEffect - 3)^(1/1) ~ (1 | Subject) + (1 | Version) + Extrav +
         Neuro + Psycho + EnvStim + ProStruc + SocComp + Extrav *
         SocComp + Neuro * EnvStim + Neuro * SocComp + Psycho * ProStruc +
         Extrav * EnvStim + EnvStim * SocComp + Psycho * SocComp +
         Psycho * EnvStim + Extrav * SocComp * EnvStim + Neuro * SocComp *
         EnvStim + Psycho * SocComp * EnvStim
REML criterion at convergence: 14703.9
```

Scaled residuals:

Min	1Q	Median	3Q	Max
-3.3991	-0.6887	0.0377	0.6653	3.5534

Random effects:

Groups	Name	Variance	Std.Dev.
Subject	(Intercept)	0.125098	0.35369
Version	(Intercept)	0.001597	0.03996
Residual		0.550476	0.74194

Number of obs: 6384, groups: Subject, 114; Version, 4

Fixed effects:

	Estimate	Std. Error	t value
(Intercept)	0.427	0.040	10.724
Psycho	0.276	0.017	15.874
Extrav	0.427	0.017	24.553
Neuro	-0.536	0.017	-30.864
EnvStim	0.066	0.009	7.136
ProStruc	-0.009	0.009	-0.928
SocComp	0.064	0.009	6.899
Psycho:ProStruc	0.043	0.017	2.493
Extrav:SocComp	-0.101	0.017	-5.807
Neuro:EnvStim	0.015	0.017	0.884
Neuro:SocComp	0.008	0.017	0.442
Extrav:EnvStim	-0.054	0.017	-3.093
EnvStim:SocComp	0.001	0.009	0.118
Psycho:SocComp	-0.010	0.017	-0.600
Psycho:EnvStim	0.003	0.017	0.158
Extrav:EnvStim:SocComp	-0.035	0.017	-2.020
Neuro:EnvStim:SocComp	-0.013	0.017	-0.757
Psycho:EnvStim:SocComp	-0.001	0.017	-0.032

Correlation matrix not shown by default, as p = 18 > 12.
Use print(x, correlation=TRUE) or
vcov(x) if you need it

r.squaredGLMM(SubjModelmixed20)

	R2m[arginal]	R2c[conditional]
[1,]	0.1999437	0.3496301

APPENDIX D. STUDY 2 HISTORICAL CASE/SCENARIO DEVELOPMENT

D.1 Introduction

This appendix describes the selection, analysis and development of seven decision-making scenarios derived from the history the U.S. military's experience at war. These scenarios were required to support the implementation of Study 2 as described in Chapter 3 to this report as a test of the *War Room Effects Model* (*WREM*). Five of these are based on actual, historic cases of military decision-making, which include:

- General Robert E. Lee's 2 July 1863 decision to attack Union forces at Gettysburg.
- General George G. Meade's 2 July 1863 decision to defend against the Confederate attack at Gettysburg.
- General Dwight D. Eisenhower's 5 June 1944 decision to order the D-Day invasion.
- General George S. Patton's 19 December 1944 decision to attack in relief of Allied forces in Bastogne.
- General Douglas MacArthur's 23 August 1950 decision to attack North Korean forces at Inchon.

These five events were selected as prototypes for high-level military decisions. Together, they provided a modest diversity of personalities and situational conditions for time-sensitive, critical, complex, relatively discrete military problems. They were also robustly supported by historical resources. Scenario 6 was developed as a composite event by consideration of the distribution of personality and situational attributes represented by the five historically based scenarios. The seventh scenario (Scenario 0) was established as an experimental control, without particular reference to any historical events or persons.

Especially with respect to the personalities involved in the five historically based cases, the accessible histories did not directly support the development of scientifically valid estimates for descriptive attributes of the referent persons or the situations. And, while many anecdotal and circumstantial details were gleaned from the historical resources, they were often contradicted by other details. As such, the establishment of fact regarding the factors of interest was found to be a fool's errand. Thus, this use of military history was only loosely constrained by the historical record. Further to this, the validity of the scenarios was seen to derive only from their effectiveness as representations (i.e. experimental treatment combinations) of the decision-making events.

D.2 Historical Research Objective

The objective of this research was to identify a diverse set of military decision-making events for use in the development of experimental scenarios and stimuli to support Study 2. Between five and eight historical cases were estimated as required to support the examination of *WREM*'s core experimental factors across a range of each experimental factor's theoretic strength, and their interactive effects on decision-making performance. The stimuli required for each scenario included a narrative and a word picture as described in Sections 3.5.1.1 and 3.5.1.2 of Chapter 3. Summaries were also prepared for each as described in Sections 3.5.1.3 of Chapter 3.

The history of war is not replete with details of how key decisions were made. Where records of such events do exist, they unevenly address specific details related to the problem, the decision maker or the circumstances of decision. Nonetheless, five cases were identified that were relatively well-recorded and which met the following criteria for selection:

- The case involved a prominent American military commander and a key battle from the modern era with well-developed historical resources.[192]
- The case centered on a decision taken by a single, responsible individual through a discrete, deliberative process and implemented according to the decision made.
- The case did not involve contemporary subjects as the decision makers in order to avoid impugning living persons by adjudication of their personalities and/or the quality of their judgments.

Several high-profile decision-making events were evaluated for their suitability as cases for this study. However, most were excluded from detailed evaluation due to their failure to meet one or more of the selection criteria. Eventually, the five cases listed at the start of this appendix were selected as the most suitable for analysis and provided for a diversity of individual and circumstantial characteristics.

In the examination of these selected cases, every effort was made to achieve the best possible correspondence between the recorded details of the decision-making events and their descriptor-based representation. This required some interpretation on the part of this researcher due to contradictions within and between the historical sources and the limited number of available descriptors. As such, certain deviations from the historical facts were ultimately required. However, in the end, these analyses led to the identification of the evidence required to support the development of each case as an experimental scenario and its representation by stimuli.

Evidence was obtained for each case to support assessments for the estimated strength (low, moderate or high)[193] of each component subfactor of *WREM*'s core

[192] According to Dupuy & Dupuy (1993, p. 898), "the American Civil War was truly the first modern war." This was credited to advances in military theory, tactics, technologies, doctrine and professionalism. This criterion was included to ensure the accessibility of English language resources and to avoid misinterpretations caused by cultural and linguistic miscues.
[193] Subfactor strengths were assigned at three levels with '-1' as low, '0' as moderate and '1' as 'high'.

variables, which included: *creative* and *tough-minded* for *Psychoticism (Psych); assertive* and *sociable* for *Extraversion (Extrav); anxious* and *emotional* for *Neuroticism (Neuro); visual, auditory* and *haptic/other* for *Environmental Stimulation (EnvStim); logic, rigor* and *clarity* for *Process Structure (ProStruc);subordinate information, goal congruence, subordinate conflict* and *social composition* for *Support Group (SptGrp.)*[194].

After assessing the probable strength for each subfactor for each case, descriptors were drawn from Tables B.1 and B.2 of Appendix B and assigned to the respective case for their consolidation as scenarios and their inclusion in the associated stimuli. As recorded in Table 3.1 of Chapter 2, overall factor strengths for each case were then calculated as the unweighted mean of the component subfactor strength levels. To support the representation of the experimental control factors (*Intelligence, Experience, Conscientiousness* and *Decision Typology*), descriptors were drawn from Study 1 control factor descriptors at Table B.3 of Appendix B and included as components of each scenario's stimuli as a deliberate departure from the historical record. These control factor assignments were established at the same strength level for all scenarios. Together, these personality, situational and control factor descriptors provided the lexical components required for the composition of narratives and word pictures.[195]

D.3 Case Analysis and Scenario Development

The following section summarizes the analysis of historic cases and their further development as experimental scenarios.

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[194] Study 2 experimental factors and subfactors were as established at Chapter 3, Section 3.2 to this report.
[195] Scenario word pictures are discussed at Chapter 3, Section 3.5.1.3 with an example provided at Figure 3.1. All word pictures, narratives and summaries are available in the document entitled "Personality and Situational Effects in Decision Making" included as a supplementary file to this report.

D.3.1 Case/Scenario 1: Lee's Decision for Day 3 at Gettysburg

The first case derived from the events surrounding General Robert E. Lee's overnight decision on July 2nd, 1863 to conduct a coordinated assault on the center of the Union line on the following day at Gettysburg. Several historical resources provided insight about Lee's decision on the eve of Gettysburg's culminating battle.

This diverse literature made clear that Lee shunned the opportunity to convene the traditional council of war[196] that might have better-supported his judgment and decision making that night (Gompert & Kugler, 2006). However, it was unclear that this decision was (or could have been) made through a discrete and formalized decision-making process. On the contrary, the lack of any record for such a decision was sufficient to suggest that no formal, deliberative event took place.

More likely, Lee came to a solitary conclusion about his next day's strategy during the course of his battlefield circulation on the evening of July 2nd. He was likely supported (or confounded) in his thinking by unstructured and unrecorded consultation among subordinates, aides-de-camp, couriers and spies (Longstreet, 1896; Freeman, 1935; Shaara, 1974). On the other hand, Lee may have determined all along to attack at the Union center and was unmoved from such a notion by the facts on the battlefield or the advice of his subordinates (Gompert & Kugler, 2006). Either way, it was seen as reasonable to characterize Lee's decision as an event for the purposes of this study.[197]

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[196] The council of war (or war council) is a traditional, collaborative decision making paradigm, typically reserved for critical wartime decisions. See footnote 1 for further discussion.

[197] It was concluded that Lee's decision constituted a consultative decision-making process and event according to the *Vroom Yetton model* of decision-making (Vroom & Jago, 1988). The *Vroom-Yetton model* describes solitary decision making as a consultative leadership type when it is supported by one-on-one

Whatever the truth, various aspects of the man, the environment and his decision are known. And, because the decision led to conspicuous failure, it is especially valuable as it can be juxtaposed with the winning decision made by George Meade that same night. The case also highlights the implications of subordinate exclusion from the decision-making process as would predict poor outcomes according to the *Vroom-Yetton* model (Vroom & Yetton, 1973; Vroom & Jago, 1988).

Across the available literature, there was ample evidence that Lee was both high in *creativity* and highly *tough-minded* (Freeman, 1934, 1935; Dowdey, 1965; Coddington, 1968; H. Longstreet, 1904; Shaara, 1974; Suedfeld, Corteen & McCormick, 1986; Suedfeld, Guttieri & Tetlock, 2003; Piston, 1994). This was sufficient to support a conclusion that Lee would have measured high on the scale for *Psych.* The evidence also indicated that Lee would have measured low for both *sociable* and *assertive* (Lee, 1904; Freeman, 1934, 1935; Dowdey, 1965; Shaara, 1974), which was sufficient to conclude that he would have measured low on the scale of *Extrav.* And while there is some disagreement about his distressed state at Gettysburg, the evidence supported an assessment that Lee was both highly *anxious* and *emotional* (Lee, 1904; Freeman, 1934, 1935; Dowdey, 1965; Coddington, 1968; H. Longstreet, 1904; Gompert & Kugler, 2006; Shaara, 1974). This was sufficient to support a conclusion that Lee would have measured high on the scale of *Neuro.*

The literature indicated that any decision taken by Lee for the next day's attacks must have occurred during the night on the outskirts of a dimly lit command post after the conclusion of the preceding day's battle. This supported an assessment that there would

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collaboration with subordinates (Vroom, & Yetton, 1973; Vroom & Jago, 1978, 1988). See Chapter 1, Figure 1.4 for a description of the *Vroom-Yetton model.*

have been little *visual* or *auditory* stimulation that might have affected his judgment (Shaara, 1974; Freeman, 1935; Coddington, 1968;). That said, the heat and humidity of the summer evening, the typical discomforts of a battlefield command post, and Lee's unstructured circulation among subordinates, staff and aides-de-camp supported an assessment that *haptic/other* stimulation was high (Freeman, 1935; Coddington, 1968; Shaara, 1974). As such, this supported a conclusion that *EnvStim* was moderately low.

A broad swath of literature established that Lee's deliberative processes were anything but logical, rigorous or clear (Freeman, 1935; Dowdey, 1965; Coddington, 1968; H. Longstreet, 1904; Gompert & Kugler, 2006; Shaara, 1974). This supported an assessment that the erst-while decision-making event was high on the scale for *ProStruc*.

The composition of Lee's decision support group was somewhat complex, with each member only haphazardly included and partially informed of relevant details regarding the next day's risks and opportunities. In addition, these subordinates' goals were moderately divergent, although they were unlikely to create conflict concerning any decision taken (Freeman, 1935; Dowdey, 1965; Coddington, 1968; Woodworth, 1990; Shaara, 1974). These assessments supported a conclusion that the event was moderately low for *SptGrp*.

Each of the above assessments supported the assignment of subfactor descriptors drawn from Tables B.1, B.2 and B.3 of Appendix B.[198] When combined with other specific details related to the strategic context for the decision and the experimental control factor descriptors, these provided the basis for development of the scenario narrative and word

[198] See Section 3.5.1 of Chapter 3 for discussion.

picture. The following summary was provided to Study 2 subjects as a transition between Scenario 1 and the other core scenarios of Study 2.[199]

> ***Scenario 1 Historical Basis:*** *The historical basis for this scenario is General Robert E. Lee's overnight decision to attack the Army of the Potomac on 3 July 1863 at Gettysburg. General Lee personally consulted only with selected subordinates, including a significant and contentious discussion with General James Longstreet, who strongly recommended against Lee's proposed concepts for the attack. There is ample evidence that no specific decision-making event ever took place, as Lee chose to consider his options and decide alone at his headquarters. This decision led to an infamous assault on the Union's center, which culminated in the Union's repulse of Pickett's charge and the subsequent retreat of the Army of Northern Virginia.*

This is available with the scenario narrative and word picture at pp. 8-11 of the supplementary file entitled "Assessment of Decision Making for Different Situations".

D.3.2 Case/Scenario 2: Meade's Decision for Day 3 at Gettysburg.

The second case derived from the events surrounding General George G. Meade's July 2nd, 1863 decision to defend against a general assault by Confederate forces that was expected on the following day. The analysis of this case benefitted from many of the same excellent resources used to analyze Lee's concurrent decision. In contrast to Lee's decision-making approach, the record is clear that Meade took advantage of the council of war as the only formalized decision-making process available to military commanders at that time (Gibbon, 1888; Coddington, 1968).

Meade's council of war was recorded in elaborate detail and well-represented in the many scholarly works related to Gettysburg (Gibbon, 1888; Coddington, 1968). More than any other use case in this study, this archetypical event was especially useful for its

[199] Sources that directly supported development of this summary included Freeman (1935), Coddington (1968), Dowdey (1965), Gibbon (1888), Gompert & Kugler (2006), Cleaves, (1991) and Shaara (1974).

comparison to Lee's corresponding decision-making pseudo-event. By its successful outcome, the decision was also useful to highlight the implications of subordinate inclusion in the decision-making process (Vroom & Yetton, 1973; Vroom & Jago, 1988).[200]

Among several historical works, the descriptions of Meade's personal attributes and patterns of behavior were widely varied.[201] The descriptive behaviors and trait strength indicators provided evidence that supported assessments of personality subfactor strengths spanning from high-to-low for all relevant individual attributes. However, Gibbon's (1888) personal record of the decision-making event provided excellent support for assessing that Meade's personality was not extraordinary or eccentric, at least as indicated by his behavior at the time of the event. It was thus concluded that Meade's *Psych*, *Extrav* and *Neuro* and their subfactors would have measured as moderate across the board (Walker, 1888; Gibbon, 1888; Coddington, 1968; Rafuse, 2003; Guelzo, 2013; Sauers, 2003; W. Jones, 2004; Cleaves, 1991; Boritt, 1994; Shaara, 1974).

As supported by other histories of Meade's council of war, Gibbon's (1888) record also provided detailed insights into the physical circumstances of the event. This supported an assessment that *visual* stimulation was low, while *auditory* and *haptic/other* stimulation were moderate (Coddington, 1968; Gibbon, 1888; Shaara, 1974). These assessments led to a conclusion that *EnvStim* was moderately low.

The literature also supported an assessment that Meade's council was conducted

[200] The *Vroom-Yetton model* excludes autocratic decision making from the feasible set of decision-making strategies when there is a likelihood for conflict among subordinates about a possible decision (Vroom & Yetton, 1973; Vroom & Jago, 1988). See Section 1.3.3 of Chapter 1 for further discussion.
[201] The contradictions among historical reports reflect the divergent motivations and perspectives of the various authors. Meade's reputation was indelibly affected by his involvement in a politicized controversy related to the maneuver of the Union Army's 3rd Corps on the last day at Gettysburg (Sauers, 2003).

logically, rigorously and the process was clearly understood by the event's participants (Meade 1923; Rafuse, 2003; Cleaves, 1991; Gibbon 1888; Shaara, 1974). This supported a conclusion that the event was moderate for *ProStruc*.

Meade's council was attended by a relatively large and diverse group of subordinates and staff. These participants were each only partially informed of the situation across the battlefront. They were also highly competitive and divergent in their goals and susceptible to conflict over a decision (Meade, 1923; Rafuse, 2003; Coddington, 1968; Gibbon, 1888; Cleaves, 1991; Shaara, 1974). These assessments led to a conclusion that the event was high for *SptGrp*.

The above assessments supported the assignment of subfactor descriptors to the case. When combined with other specific details related to the event, these provided the basis for development of the scenario narrative and word picture. The following summary was provided to Study 2 subjects as a transition between Scenario 2 and the other core scenarios of Study 2.[202]

> ***Scenario 2 Historical Basis:*** *The historical basis for this scenario is General George Meade's overnight decision to remain in defense at Gettysburg to defeat the Confederate attacks of 3 July 1863. Late on 2 July, General Meade convened a Council of War with his key subordinates and selected staff at a small farmhouse on the Union front lines. Consistent with military custom, the Council of War delivered an ordered presentation of commander assessments and recommendations for Meade's consideration and decision. This decision led to the successful defense of Gettysburg and the subsequent retreat of General Robert E. Lee's Army of Northern Virginia.*

This is available with the scenario narrative and word picture at pp. 11-14 of the

[202] Sources that directly supported development of this summary included Freeman (1935), Coddington (1968), Gibbon (1888), Cleaves (1991), Boritt (1994), W. Jones (2004), Guelzo (2013) and Shaara (1974).

supplementary file entitled “Assessment of Decision Making for Different Situations”.

D.3.3 Case/Scenario 3: Eisenhower’s Decision for the D-Day Invasion

The historical basis for this scenario is taken from General Eisenhower’s decision of June 5th, 1943 to initiate the massive amphibious assault on *Fortress Europe* and commence the allied drive to defeat Nazi Germany. Many histories record the D-Day decision-making event, which had been rehearsed for months in advance (Butcher, 1946; W. Smith & Eisenhower, 1956; S. Weintraub, 2003; Rives, 2014; D’Este, 1976; Center of Military History [CMH], 1990). The circumstances of the D-Day decision and Eisenhower’s personal attributes were particularly well-recorded. On the whole, they provided keen insight into the factors affecting his epic decision for commitment to the Allied invasion at Normandy.

The historical evidence supported a confident assessment that Eisenhower would have measured at moderate strength for all personality subfactors, except for *sociable* and *emotional.* For these, it was assessed that he would have measured at low strength (Butcher, 1946; W. Smith & D. Eisenhower, 1956; S. Weintraub, 2003; Rives, 2014; D’Este, 1976; Center of Military History [CMH], 1990). These assessments supported a conclusion that Eisenhower would have been measured with moderate *Psych,* moderately low *Extrav* and moderately low *Neuro*.

The event was undertaken in a comfortable and familiar environment that was moderate for *visual* and *auditory* stimulation, and low for *haptic/other* stimulation (Harrison, 1951; W. Smith & D. Eisenhower, 1956; D’Este, 1976). Subfactors representing *ProStruc* were each assessed as moderate for this well supported and rehearsed event

(Harrison, 1951; D. Eisenhower, 1948; W. Smith & D. Eisenhower, 1956; D'Este, 1976). The three subfactors for *SptGrp* were assessed as low including *subordinate information*, *goal congruence* and *social composition*. However, *subordinate conflict* was assessed as high given the history of intramural tensions certain participants (Harrison, 1951; D. Eisenhower, 1948; Morgan, 1950; Harrison, 1951; W. Smith & D. Eisenhower, 1956; D'Este, 1976; Crosswell, 1992). These assessments supported a conclusion that the event was moderately low for *EnvStim* and *SptGrp*, and moderate for *ProStruc*.

These assessments supported the assignment of subfactor descriptors and provided the basis for development of the scenario narrative and word picture. The following summary was provided to Study 2 subjects as a transition between Scenario 3 and the other core scenarios.[203]

> ***Scenario 3 Historical Basis:*** *The historical basis for this scenario is General Dwight D. Eisenhower's time-sensitive decision to launch the D-Day attacks of 6 June 1943. As Supreme Commander, General Eisenhower convened a well-rehearsed decision-making event with his key subordinates and staff at his headquarters in Hampshire, England. Eisenhower and his command group reviewed crucial details of the operation and specifically confirmed that the dynamic threat and weather conditions would permit initiation of the massive D-Day invasion. This decision led to the successful breach of Germany's Fortress Europe and the opening of the decisive front for World War II' in central Europe.*

This is available with the scenario narrative and word picture at pp. 15-18 of the supplementary file entitled "Assessment of Decision Making for Different Situations".

D.3.4 Case/Scenario 4: Patton's Decision for the Relief of Bastogne

The historical basis for this case was taken from General George Patton's decision to attack and relieve besieged U.S. forces in Bastogne at the height of the *Battle of the*

[203] Sources that directly supported development of this summary included J. Smith (2012), Ambrose (2016), Willoughby & Chamberlain (1954), Karig, Cagle & Manson (1952) and W. Smith (1956).

Bulge. The circumstances of this event make it unique in that the decision maker (Patton) was placed in a situation where his deliberations were only directly supported by an assembly of superior commanders and staffs. Patton had been summoned to a meeting at Verdun with General Eisenhower and his alliance chiefs to decide on a maneuver option for Patton's own U.S. Third Army. Patton was effectively deciding for and alongside three echelons of command at once, in the presence of his superior commanders and their key staff (S. Weintraub, 2007; D'Este, 1976). Patton's advance preparations for this event produced three cursory maneuver options, for which his subordinate commanders had assured their support. Thus, the conference at Verdun served mainly to confirm Patton's assumptions and permit his selection from among these options as his decision (D'Este, 1976).

Few individuals figure more prominently in the annals of U.S. military history than George Patton. As such, multiple resources provided insight into the personal qualities of the man and the conditions of the commander's conference at Verdun. Although he is widely recorded as a volatile persona (McDonald, 1985; J. Eisenhower, 2012), the bulk of evidence indicated that Patton would have measured at high strength for all personality subfactors except for *sociable* and *anxious* (Semmes, 1955; D'Este, 1976; McDonald, 1985; Nye, 1993; S. Weintraub, 2007; Rickard, 2011; J. Eisenhower, 2012; Province, 1992). For these two subfactors, it was assessed that he would have been measured at moderate strength (J. Eisenhower, 2012; Province, 1992). This supported a conclusion that Patton would have measured high for *Psych* and moderately high for *Extrav* and *Neuro*.

Patton's decision was taken in an environment where the subfactors for *EnvStim* were each assessed as moderate (D'Este, 1976; S. Weintraub, 2007; Rickard, 2011; J.

Eisenhower, 2012). Given the absence of structure – or even precedent – for such a decision-making event, the subfactors for *ProStruc* were each assessed as high (Nye, 1993; Goldstein, Wenger & Dillon, 2001). And finally, the subfactors for *SptGrp* were assessed as low as the assembled group was rather small, well-acquainted and generally collegial (Blumenson, 1974; D'Este, 1976; S. Weintraub, 2007; Rickard, 2011). These assessments supported a conclusion that the event would have measured moderate for *EnvStim*, high for *ProStruc* and low for *SptGrp*.

These assessments supported the assignment of subfactor descriptors and provided the basis for development of the scenario narrative and word picture. The following summary was provided to Study 2 subjects as a transition between Scenario 4 and the other core scenarios.[204]

> ***Scenario 4 Historical Basis:*** *The historical basis for this scenario is General George Patton's decision to turn his 3rd Army from their continued attacks toward Germany, and attack in a new direction to lift the siege of US forces in Bastogne, Belgium. On 19 December 1944, General Eisenhower called Patton to a chateau in Verdun, France to confer with Alliance leadership. Patton was aware that he would be required to recommend options for the relief of encircled forces in Bastogne and prevent a widening breach of the Alliance offensive front. Before his departure to Verdun, Patton prearranged three maneuver options with his key subordinates. However, selection of an option depended on the outcome of discussions with the Alliances' senior commanders. At the Verdun meeting and without further collaboration with his own subordinates and staff, Patton confirmed the necessary details to make his decision for an armored assault deep into the German offensive front. Patton's attack broke the Germen encirclement of Bastogne and restored the integrity of the Alliance offensive front.*

This is available with the scenario narrative and word picture at pp. 18-21 of the supplementary file entitled "Assessment of Decision Making for Different Situations".

[204] Sources that directly supported development of this summary included Blumenson (1974), D'Este (1976), McDonald (1985), S. Weintraub (2007), J. Eisenhower (2012) and Nye (1993).

D.3.5 Case/Scenario 5: MacArthur's Decision for the Inchon Landings

Similar to Eisenhower's decision or D-Day, this event was extensively supported by advance coordination, preliminary decisions and preparatory conferences over the preceding days and weeks (Karig, Cagle & Manson, 1952; Blair, 1989). However, in contrast with Eisenhower's decision, MacArthur's was not designed to trigger the actual attacks (Karig et al., 1952; Willoughby & Chamberlain, 1954). Instead, the decision initiated the execution planning required among the affected military departments and subordinate commands and allies to support the operation in the following month (Karig et al., 1952; Willoughby & Chamberlain, 1954; Heinl, 1972; Blair, 1989; Simmons, 2000). And, as outrageous as this decision may have seemed at the time, it set in train one of the most brilliantly successful amphibious maneuvers in military history (Blair, 1989; Willoughby & Chamberlain, 1954; Heinl, 1972).

The circumstances of MacArthur's decision and the reported nature of his personality suggest that the defining characteristics of both the person (MacArthur) and the event would be best described as eccentric. The historical evidence provided ample support for an assessment that MacArthur would have measured low on the subfactors for *Neuro* (Manchester, 1978; Langley, 1979; Blair, 1989) and high for all other personality subfactors (Karig et al., 1952; Willoughby & Chamberlain, 1954; Heinl, 1972; Manchester, 1978; Langley, 1979; James, 1985; Blair, 1989; Dupuy, Johnson & Bongard, 1995; Simmons, 2000; J. Smith, 2012). These assessments supported the conclusion that the general would have been measured as high for *Psych* and *Extrav* and low for *Neuro*.

The event itself was widely recorded as being both scripted and theatrical (Heinl, 1972; Langley, 1979; James, 1985; Blair, 1989. The conference's attendees were a veritable 'who's who' of U.S. military leadership at the onset of the Korean conflict, with many of the participants possessed of serious doubts with respect to MacArthur's judgment (Karig et al., 1952; Willoughby & Chamberlain, 1954; Heinl, 1972; Langley, 1979; James, 1985; Blair, 1989). This supported an assessment that the subfactors related to *ProStruc* would have measured low, while the subfactors related to both *EnvStim* and *SptGrp* would have been measured high. This led to a conclusion that *ProStruc* would have been measured as low, and *EnvStim* and *SptGrp* would have been measured as high.

These assessments supported the assignment of subfactor descriptors and provided the basis for development of the scenario narrative and word picture. The following summary was provided to Study 2 subjects as a transition between Scenario 5 and the other core scenarios.[205]

> ***Scenario 5 Historical Basis:*** *The historical basis for this scenario is General Douglas MacArthur's decision to envelop North Korean forces at Inchon, South Korea and relieve the pressure on United Nation's forces in the Pusan Perimeter. On 3 August 1950, MacArthur hosted a large assembly of commanders and staff at his Tokyo headquarters. This group included a significant contingent from the US Joint Chiefs of Staff. The thoroughly-scripted event was vigorously contested by selected attendees, despite MacArthur's accommodation for the presentation and discussion of their considerations of risk and maneuver alternatives. In the end, MacArthur himself provided a theatrical and forceful presentation of the Inchon option's merits, despite his acknowledgement of poor odds for success. Given General MacArthur's gravitas, his contrary decision was certain to prevail with the US Joint Chiefs and the US President who would secure the necessary reinforcements. This decision set the course for one of the most astounding military reversals in the history of amphibious warfare, as it forced North Korean forces into a precipitous retreat from South Korea.*

This is available with the scenario narrative and word picture at pp. 22-25 of the supplementary file entitled "Assessment of Decision Making for Different Situations".

[205] Sources that directly supported development of this summary included Willoughby & Chamberlain (1954), Langley (1979), J. Smith (2012), and Heinl (1972).

D.3.6 Scenario 6: Composite Decision-making Event

As indicated previously, the sixth scenario (Scenario 6) was designed as a composite event to counterbalance for the distribution of personality and situational attributes that resulted from the selection and development of the five historically based scenarios. Subfactor descriptors were assigned according to target strength levels to adjust for the experimental design imbalances imposed collectively by the other five cases/scenarios. These assignments were guided by this researcher's contemporary experience in military decision-making events.[206] The following section describes the assignment of strength levels to subfactors and factors for this composite event.

For the personality subfactors, descriptors were assigned for the low level of *creative* and *tough-minded* because these subfactors had not been assigned at that level for any other case/scenario. Settings for other personality subfactors were assigned to improve the balance of examination across the range of each personality factor with descriptors assigned for *assertive* and *anxious* at the low level, *emotional* at the moderate level, and *sociable* at high. These descriptor assignments resulted in the establishment of low *Psych*, moderate *Extrav* and moderately low *Neuro* for the composite decision maker.

For the situational subfactors, each of these had been represented at all three levels by one or more of the five historically based cases. As such, all situational subfactor setting assignments were made to improve the balance across the subfactor strength ranges. Subfactors for *auditory* and *haptic/other* stimulation, *logic, clarity, rigor* and *subordinate*

[206] Between 2001 and 2014, this researcher was assigned to various official duties in support of U.S. military operations in Afghanistan, Iraq, Yemen and Syria with a focus on campaign planning, strategy and U.S. Department of Defense policy.

conflict were all assigned descriptors at the low level. Moderate level descriptors were assigned for *visual* stimulation. And finally, high level descriptors were assigned for *goal congruence* and *social composition*. These assignments resulted in the establishment of moderately low *EnvStim,* low *ProStruc* and moderate *SptGrp*.

These assessments supported the assignment of subfactor descriptors and provided the basis for development of the scenario narrative and word picture. The following summary was provided to Study 2 subjects as a transition between Scenario 6 and the other core scenarios.

> ***Scenario 6 Historical Basis:*** *This is a composite scenario developed to round-out the set of scenarios with decision maker personality and situational conditions necessary to consider the theoretic scope of decision-making conditions. There is no specific historical basis. Modern US-led military coalition decision-making processes since 2001 provide a possible basis for decision-making events that could be described by this combination of conditions. However, modern coalition decision-making processes are generally more interdependent with US-directed inter-governmental decision-making processes and political direction. Thus, they are more difficult to isolate as discrete and effective events.*

This is available with the scenario narrative and word picture at pp. 25-28 of the supplementary file entitled "Assessment of Decision Making for Different Situations".

D.3.7 Scenario 0: Baseline/ Control Decision-making Event

Scenario 0 was included as an experimental control and to allow for collection of a baseline of subject response data. All situational descriptors were assigned at the moderate level as the control setting. However, there was no specification of personality descriptors. This scenario was supported only by a word picture composed from the lexical descriptors for the situational subfactors and experimental control factors.[207] This is available with the at p. 6 of the supplementary file entitled "Assessment of Decision making for Different Situations".

D.4 Appendix Summary

These seven scenarios and their associated stimuli directly supported representation of the Study 2 experimental treatment combinations with coverage across the practical range of core experimental factors. The actual employment of these scenarios to the experimental runs of the study is discussed at Chapter 3, Section 3.4.1.

[207] As described in Chapter 3, Section 3.5.1.1 subject personality measures were planned for imputation as the personality factors for the analysis of the subject response to this scenario.

APPENDIX E: STUDY 2 DESCRIPTORS

Tables E.1 and E.2 provide the personality and situational descriptors and descriptors selected for use in stimuli development for Study 1.

Table E.1: Study 2 Personality Descriptor Assignments

	Case/Scenario	Personality Factors					
		Psychoticism		**Extraversion**		**Neuroticism**	
		Creative	**Tough-minded**	**Sociable**	**Assertive**	**Anxious**	**Emotional**
Factor-level Descriptor Assignment by Case	**Scenario 0 Baseline/Control**	Not Assigned	Not Assigned	Not Assigned	Not Assigned	Not Assigned	Not Assigned
	Scenario 1 Lee 2-3 JUL 1863 near Gettysburg, PA	very creative / innovative	toughminded / stubborn	shy / very shy	accommodating / timid	nervous / tense	passionate / moody
	Scenario 2 Meade 2-3 JUL 1863 near Gettysburg, PA	original / creative	reasonable / considerate	sociable / approachable	cooperative / assertive	sensitive / anxious	moderately stable / moderately emotional
	Scenario 3 Eisenhower 5 JUN 1944 near Portsmouth, UK	original / creative	reasonable / considerate	shy / very shy	cooperative / assertive	sensitive / anxious	stable / unemotional
	Scenario 4 Patton 19 DEC 1944 near Verdun, FR	very creative / innovative	toughminded / stubborn	sociable / approachable	demanding / dominant	sensitive / anxious	passionate / moody
	Scenario 5 MacArthur 23 AUG 1950, near Tokyo, JA	very creative / innovative	toughminded / stubborn	outgoing / very forward	demanding / dominant	calm / very relaxed	stable / unemotional
	Scenario 6 Composite	unoriginal / unimaginative	agreeable / submissive	outgoing / very forward	accommodating / timid	calm / very relaxed	moderately stable / moderately emotional

Table E.2: Study 2 Situational Descriptor Assignments

	Case/Scenario	Situational Factors									
		Environmental Stimulation			Process Structure			Decision Support Group			
		Auditory	Visual	Haptic \ Other	Logic	Clarity	Rigor	Subordinate Information	Goal Congruence	Subordinate Conflict	Social Composition
Factor-level Descriptor Assignment by Case	**Scenario 0** **Baseline/Control**	even-toned	well lit	settled	sensible / informed / progressive	common practice	flexible	Mixed Awareness	Mixed Goal Congruence	Mixed Agreeableness	Medium-sized / Mixed Familarity / Mixed Dominance
	Scenario 1 **Lee** **2-3 JUL 1863** **near Gettysburg, PA**	muffled	dim	bustling	intuitive/ inductive / recursive	improvised	relaxed	partially informed	goal-congruent	agreeable	small / well-acquainted / collegial
	Scenario 2 **Meade** **2-3 JUL 1863** **near Gettysburg, PA**	even-toned	dim	settled	sensible / informed / progressive	common practice	flexible	partially informed	goal-divergent	competitive	large / unfamiliar / high-spirited
	Scenario 3 **Eisenhower** **5 JUN 1944** **near Portsmouth, UK**	even-toned	well lit	soothing	sensible / informed / progressive	common practice	flexible	comprehensively informed	goal-congruent	competitive	small / well-acquainted / collegial
	Scenario 4 **Patton** **19 DEC 1944** **near Verdun, FR**	even-toned	well lit	settled	intuitive/ inductive / recursive	improvised	relaxed	comprehensively informed	goal-congruent	agreeable	small / well-acquainted / collegial
	Scenario 5 **MacArthur** **23 AUG 1950,** **near Tokyo, JA**	loud	dazzling	bustling	rational / deductive / methodological	doctrinal	meticulous	partially informed	goal-divergent	competitive	large / unfamiliar / high-spirited
	Scenario 6 **Composite**	muffled	well lit	soothing	rational / deductive / methodological	doctrinal	meticulous	comprehensively informed	goal-divergent	agreeable	large / unfamiliar / high-spirited

APPENDIX F: STUDY 2 MIXED-MODEL REGRESSION RESULTS

These analyses are performed in R using lmer and r.squaredGLMM functions. These functions require the lme4; MuMIn packages.

Factor labels are as follows for this analysis:

DxQual - DxEffect
Subj - Subject
SubjPsychFix - SubjPsychFix
P - Psych
E - Extrav
N - Neuro
C - EnvStim
S - ProStruc
G - SptGrp

See Section 3.2 of Chapter 3 for factor definitions.

Linear mixed model fit by REML ['lmerMod']

Formula: (DxEffect - 3)^(1/1) ~ (1 | Subj) + P + E + N + C + S + G + P * C + P * S + P * G + E * C + E * G + N * C + N * G + C * G + P * C * G + E * C * G + N * C * G + (1 | SubjPsychFix)
Data: Study2Completeredux

REML criterion at convergence: 451.7

Scaled residuals:

Min	1Q	Median	3Q	Max
-3.0593	-0.6997	0.1138	0.6248	1.8577

Random effects:

Groups	Name	Variance	Std.Dev.
Subj	(Intercept)	0.00997	0.09985
SubjPsychFix	(Intercept)	0.01996	0.14128
Residual		0.63881	0.79926

Number of obs: 182, groups: Subj, 22; SubjPsychFix, 14

Fixed effects:

	Estimate	Std. Error	t value
(Intercept)	0.647803	0.18872	3.433
P	-0.016321	0.234416	-0.07
E	0.27089	0.177581	1.525
N	-0.132644	0.10968	-1.209
C	-0.347955	0.510605	-0.681
S	0.085521	0.213468	0.401
G	-0.009005	0.242017	-0.037
P:C	0.944869	0.611848	1.544
P:S	-0.274683	0.282237	-0.973
P:G	-0.796498	0.329592	-2.417
E:C	-0.553514	0.468787	-1.181
E:G	0.360548	0.204639	1.762
N:C	0.11777	0.295485	0.399
N:G	0.00674	0.131081	0.051
C:G	0.335501	0.643913	0.521
P:C:G	-1.591539	0.782131	-2.035
E:C:G	0.86164	0.55057	1.565
N:C:G	-0.042724	0.370967	-0.115

Correlation matrix not shown by default, as p = 18 > 12.
Use print(x, correlation=TRUE) or
vcov(x) if you need it

r.squaredGLMM(SubjModelmixed20)

	R2m[arginal]	R2c[conditional]
[1,]	0.2698556	0.3025332

APPENDIX G: STUDY 2 CONTROL POLICY ASSESSEMENT RESULTS

Tables G.1, G.2 and G.3 depict the fixed effects reported for the mixed-effects analysis of *EnvStimLvl*, *ProcStimLvl* and *GrpStimLvl* as a policy capturing response variables for Study 2 experimental data.

Table G.1: Results for *EnvStimLvl* Control Policy Assessment

Control Policy: *Environmental Stimulation* (*EnvStimLvl*) Mixed Model Regression Results (Fixed-factors Only)					
Fixed Effects	Coefficient	Std Error	t – Value	p – Value	Significance * : p < 0.25 ** : p < 0.10 *** : p < 0.05
(Intercept)	0.144	0.080	1.798	0.075	**
Psych	0.071	0.075	0.943	0.347	
Extrav	-0.033	0.059	-0.568	0.571	
Neuro	0.017	0.046	0.366	0.715	
EnvStim	0.530	0.079	6.676	0.000	***
ProStruc	-0.146	0.071	-2.051	0.043	***
SptGrp	-0.086	0.066	-1.298	0.197	*
Extrav:SptGrp	-0.000	0.073	-0.003	0.998	
Neuro:EnvStim	0.078	0.084	0.930	0.355	
Neuro:SptGrp	-0.021	0.062	-0.336	0.738	
Psych:ProStruc	-0.096	0.087	-1.107	0.271	

Table G.2: Results for *ProcStimLvl* Control Policy Assessment

Control Policy: *Process Structure* (*ProcStimLvl*) Mixed Model Regression Results (Fixed-factors Only)					
Fixed Effects	Coefficient	Std Error	t – Value	p – Value	Significance * : p < 0.25 ** : p < 0.10 *** : p < 0.05
(Intercept)	0.058	0.100	0.584	0.670	
Psych	0.047	0.107	0.438	0.662	Implicated
Extrav	0.030	0.084	0.362	0.718	
Neuro	0.104	0.065	1.599	0.113	*
EnvStim	-0.100	0.114	-0.876	0.383	
ProStruc	0.137	0.102	1.337	0.184	*
SptGrp	0.150	0.095	1.572	0.119	*
Extrav:SptGrp	0.127	0.106	1.194	0.235	*
Neuro:EnvStim	-0.086	0.120	-0.716	0.476	
Neuro:SptGrp	0.044	0.089	0.490	0.625	
Psych:ProStruc	0.288	0.125	2.309	0.023	***

Table G.3: Results for *GrpStimLvl* Control Policy Assessment

Control Policy*: Support Group (GrpStimLvl*) Mixed Model Regression Results (Fixed-factors Only)					
Fixed Effects	Coefficient	Std Error	t – Value	p – Value	Significance * : p < 0.25 ** : p < 0.10 *** : p < 0.05
(Intercept)	0.034	0.104	0.328	0.746	
Psych	0.091	0.107	0.849	0.398	
Extrav	-0.060	0.084	-0.717	0.475	Implicated
Neuro	-0.024	0.065	-0.369	0.719	
EnvStim	0.237	0.113	2.104	0.038	***
ProStruc	-0.277	0.101	-2.748	0.007	***
SptGrp	0.360	0.094	3.826	0.000	***
Extrav:SptGrp	-0.285	0.105	-2.718	0.001	***
Neuro:EnvStim	-0.037	0.118	-0.309	0.758	
Neuro:SptGrp	0.041	0.088	0.46	0.647	
Psych:ProStruc	0.119	0.123	0.964	0.3381	

APPENDIX H: RESPONSE SURFACE OPTIMIZATION STATISITICS, RELIABILITY AND THE SYSTEM OF SITUATIONAL CONTROL

Table H.1 depicts the response surface summary statistics by personality block for both the deterministic and stochastic simulations.

Table H.2 depicts the likelihood for any combination of situational conditions to produce the maximum value for *DxQual* (max(*DxQual*)) for any one replication of the stochastic *WREM* response surface simulation.

The annotation for situational factor combinations includes 'C' for *EnvStim*, 'S' for *ProStruc* and 'G' for *SptGrp*. Subscripts for each factor include 'L' for low, 'M' for moderate and 'H' for high settings. The annotation for personality factor combination blocks includes 'p', 'X' or 'P' for the low, moderate or high setting of *Psych*, 'e', 'X' or 'E' for *Extrav* and 'n', 'X' and 'N' for *Neuro.*

The three combinations for each personality block with the highest estimated reliability are shaded to highlight the primary and alternate *optimization solutions*.

Table H.1: Response Surface Summary Statistics by Personality Block

Simulated Response Surface (Deterministic vs Stochastic Block Statisics)								
Personality Block	*Deterministic mean(DxQual)*	*Stochastic mean(DxQual)*	*Deterministic var(DxQual)*	*Stochastic var(DxQual)*	*Deterministic max(DxQual)*	*Stochastic max(DxQual)*	*Deterministic min(DxQual)*	*Stochastic min(DxQual)*
pen	0.698	0.706	0.227	0.180	3.363	3.224	-2.080	-2.107
pXn	0.914	0.898	1.125	0.700	5.579	4.952	-4.774	-4.039
pEn	1.130	1.091	3.183	1.969	7.351	6.564	-6.929	-6.193
peX	0.562	0.585	0.171	0.142	2.987	3.158	-1.962	-2.044
pXX	0.779	0.777	0.933	0.574	5.202	4.585	-4.656	-3.926
pEX	0.995	0.971	2.856	1.762	6.974	6.454	-6.811	-5.903
peN	0.427	0.465	0.140	0.121	2.636	3.075	-1.815	-1.971
pXN	0.643	0.657	0.767	0.469	4.731	4.189	-4.509	-3.750
pEN	0.859	0.847	2.555	1.574	6.503	6.110	-6.664	-5.955
Xen	0.688	0.697	1.096	0.725	6.585	5.925	-3.369	-2.938
Pen	0.678	0.689	4.238	2.739	10.066	9.373	-5.369	-4.646
PEn	1.111	1.073	0.523	0.394	5.217	5.076	-2.306	-2.171
PXn	0.895	0.882	1.799	1.189	7.911	7.115	-4.008	-3.550
XeX	0.553	0.575	1.215	0.800	6.733	6.001	-3.417	-3.072
PeX	0.543	0.566	4.532	2.928	10.213	9.466	-5.426	-5.130
XXX	0.769	0.769	0.309	0.200	4.578	3.997	-2.055	-1.612
PXX	0.759	0.759	1.959	1.291	8.058	7.376	-4.055	-3.499
PEX	0.975	0.953	0.546	0.411	5.364	5.203	-2.353	-2.169
XeN	0.417	0.456	1.360	0.892	6.851	6.009	-3.567	-3.195
PeN	0.408	0.447	4.853	3.130	10.331	9.358	-5.803	-5.141
XXN	0.634	0.649	0.319	0.207	4.696	4.281	-2.093	-1.801
PXN	0.624	0.639	2.144	1.410	8.176	7.285	-4.093	-3.740
PEN	0.840	0.832	0.596	0.439	5.482	5.281	-2.391	-2.419
XEn	1.120	1.080	0.717	0.452	5.116	4.776	-3.449	-2.871
XXn	0.904	0.889	0.326	0.215	4.430	3.983	-2.007	-1.518
XEX	0.985	0.961	0.565	0.350	4.739	4.342	-3.331	-2.816
XEN	0.850	0.841	0.439	0.270	4.268	3.805	-3.183	-2.839

Table H.2: Marginal Probabilities for *max(DxQual)* by Personality Block[208]

	pen	*peX*	*peN*	*pXn*	*pXX*	*pXN*	*pEn*	*pEX*	*pEN*	*Xen*	*XeX*	*XeN*	*XXn*	*XXX*	*XXN*	*XEn*	*XEX*	*XEN*	*Pen*	*PeX*	*PeN*	*PXn*	*PXX*	*PXN*	*PEn*	*PEX*	*PEN*
$C_LS_LG_L$	17.7	11.5	6.7	24.6	23.2	21.7	27.0	25.3	23.8	0.0	0.0	0.0	11.1	5.5	2.4	32.9	33.2	31.6	0.0	0.0	0.0	0.0	0.0	0.0	2.7	1.0	0.2
$C_LS_LG_M$	2.7	1.7	0.8	2.2	2.3	2.0	1.8	1.5	1.4	0.0	0.0	0.0	2.0	0.9	0.3	4.6	4.6	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.1	0.0
$C_LS_LG_H$	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
$C_LS_MG_L$	2.2	16.5	11.4	28.6	28.0	26.7	30.2	29.6	29.3	0.0	0.0	0.0	9.9	4.9	1.9	29.1	29.5	28.1	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.4	0.1
$C_LS_MG_M$	0.3	3.9	2.0	3.4	3.5	3.4	2.3	2.1	1.9	0.0	0.0	0.0	1.6	0.8	0.1	3.7	3.8	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
$C_LS_MG_H$	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
$C_LS_HG_L$	0.0	23.2	16.3	34.4	33.8	32.7	32.6	33.8	32.7	0.0	0.0	0.0	8.6	4.4	1.7	26.1	24.4	25.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.1	0.0
$C_LS_HG_M$	0.0	6.8	4.5	5.5	5.2	4.7	3.4	2.7	2.7	0.0	0.0	0.0	1.7	0.6	0.2	3.2	3.3	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
$C_LS_HG_H$	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
$C_MS_LG_L$	22.8	1.1	1.3	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.2	1.1	5.4	5.8	4.8	0.0	0.1	0.2	0.6	0.6	0.3	1.7	1.3	1.0	8.8	6.7	5.0
$C_MS_LG_M$	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
$C_MS_LG_H$	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
$C_MS_MG_L$	4.6	1.4	1.7	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.1	0.9	3.1	3.5	3.0	0.0	0.1	0.1	0.3	0.2	0.3	0.7	0.6	0.5	3.1	2.6	2.1
$C_MS_MG_M$	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
$C_MS_MG_H$	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
$C_MS_HG_L$	0.2	2.3	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.7	0.5	1.8	2.1	1.7	0.0	0.0	0.0	0.2	0.1	0.1	0.3	0.3	0.2	1.2	0.9	0.8
$C_MS_HG_M$	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
$C_MS_HG_H$	0.0	0.1	0.3	0.1	0.1	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
$C_HS_LG_L$	30.3	9.3	14.2	0.0	0.0	0.0	0.0	0.0	0.0	35.2	34.8	34.6	22.1	27.4	31.8	0.0	0.0	0.3	40.4	39.3	39.1	42.7	41.8	41.2	37.7	40.4	41.8
$C_HS_LG_M$	4.7	0.1	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.8	0.7	0.6	1.2	1.7	0.0	0.0	0.0	0.3	0.3	0.3	0.7	0.7	0.8	1.3	1.6	1.9
$C_HS_LG_H$	0.6	0.1	0.2	0.2	0.7	1.6	0.4	1.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
$C_HS_MG_L$	7.0	9.7	15.7	0.0	0.0	0.0	0.0	0.0	0.0	32.0	33.0	32.3	17.8	22.9	26.9	0.0	0.0	0.1	31.9	32.6	33.2	30.7	32.0	31.5	25.5	27.4	28.1
$C_HS_MG_M$	1.2	0.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.6	0.5	0.4	0.6	1.2	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.3	0.5	0.4	0.5	0.5
$C_HS_MG_H$	0.2	0.3	0.6	0.4	1.2	2.9	1.0	1.6	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
$C_HS_HG_L$	0.6	10.2	17.1	0.0	0.0	0.0	0.0	0.0	0.0	27.9	27.7	29.0	14.0	19.0	21.5	0.0	0.0	0.0	25.9	26.7	26.4	23.1	22.9	24.2	16.7	18.1	19.3
$C_HS_HG_M$	0.1	0.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.4	0.1	0.3	0.8	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2
$C_HS_HG_H$	0.0	0.8	1.5	0.7	2.0	3.9	1.3	2.3	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

[208] Shaded cells in each column indicate the three situational factor combinations with the highest estimated reliability.

APPENDIX I: THE *SYSTEM OF SITUATIONAL CONTROL*

Tables I.1, I.2 and I.3 depict the *optimizations solutions* comprising *WREM*'s *system of situational control*.

Table I.1: *Optimization Solutions* for Low *Neuro* Personality Blocks

Low *Neuro*

Low *Extrav* — *pen*

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to high (</=-1.0) -0.4 slope//slope inversion	0.436	0.447
	Set ProStruc to low (>/=1.0) -0.1 slope		
	Set SptGrp to low (</=-1.0) -0.2 slope//slope inversion		
Alt 1	EnvStim mod; ProStruc low; SptGrp low	0.778	0.061
Alt 2	EnvStim low; ProStruc low; SptGrp low	1.119	0.168

Moderate *Extrav* — *pXn*

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to low (</=-1.0) -1.4 slope	2.221	0.369
	Set ProStruc to high (>/=1.0) -0.1 slope		
	Set SptGrp to low (</=-1.0) -0.6 slope		
Alt 1	EnvStim low; ProStruc mod; SptGrp low	2.134	0.351
Alt 2	EnvStim low; ProStruc low; SptGrp low	2.061	0.338

High *Extrav* — *pEn*

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to low (</=-1.0) -2.5 slope	3.156	0.745
	Set ProStruc to high (>/=1.0) -0.1 slope		
	Set SptGrp to low (</=-1.0) -1.0 slope		
Alt 1	EnvStim low; ProStruc mod; SptGrp low	3.074	0.718
Alt 2	EnvStim low; ProStruc low; SptGrp low	3.009	0.707

Xen

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to high (>/=1.0) -0.2 slope	2.336	0.69
	Set ProStruc to low (</=-1.0) -0.1 slope		
	Set SptGrp to low (</=-1.0) -0.6 slope//slope inversion		
Alt 1	EnvStim high; ProStruc mod; SptGrp low	2.277	0.633
Alt 2	EnvStim high; ProStruc high; SptGrp low	2.199	0.579

XXn

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to high (>/=1.0) -0.0 slope	1.277	0.460
	Set ProStruc to low (</=-1.0) -0.1 slope		
	Set SptGrp to low (</=-1.0) -0.3 slope		
Alt 1	EnvStim high; ProStruc mod; SptGrp low	1.209	0.418
Alt 2	EnvStim high; ProStruc high; SptGrp low	1.131	0.367

XEn

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to low (</= -1.0) -1.1 slope	2.203	0.259
	Set ProStruc to low (</=-1.0) -0.1 slope// slope inversion		
	Set SptGrp to low (</=-1.0) -0.5 slope		
Alt 1	EnvStim low; ProStruc mod; SptGrp low	2.144	0.277
Alt 2	EnvStim low; ProStruc high; SptGrp low	2.089	0.303

Pen

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to high (>/=1.0) -2.4 slope	4.248	1.490
	Set ProStruc to low (</= -1.0) -0.3 slope		
	Set SptGrp to low (</= -1.0) -2.7 slope		
Alt 1	EnvStim high; ProStruc mod; SptGrp low	4.015	1.439
Alt 2	EnvStim high; ProStruc high; SptGrp low	3.814	1.399

PXn

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to high (>/=1.0) -1.7 slope	3.176	0.84
	Set ProStruc to low (</=-1.0) -0.3 slope		
	Set SptGrp to low (</=-1.0) -1.8 slope		
Alt 1	EnvStim high; ProStruc mod; SptGrp low	2.943	0.771
Alt 2	EnvStim high; ProStruc high; SptGrp low	2.746	0.775

PEn

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to high (>/=1.0) -0.4 slope//slope inversion	2.086	0.504
	Set ProStruc to low (</=-1.0) -0.3 slope		
	Set SptGrp to low (</=-1.0) -0.9 slope		
Alt 1	EnvStim high; ProStruc mod; SptGrp low	1.883	0.469
Alt 2	EnvStim high; ProStruc high; SptGrp low	1.682	0.423

Personality labels include p, *X* or *P* for the low, moderate or high setting of Psych (Psychoticism), *e* , *X* or *E* for Extrav (Extraversion) and *n* , *X* and *N* for Neuro (Neuroticism).
Situational factors include EnvStim (Environmental Stimelation), ProStruc (process Structure) and SptGrp (Support Group).
Low, mod (moderate) and high settings represent the practical range of stimulaltion attributable to the specified situational factor.
Mean and variance (Var) indicated for each optimization solution are estimated from simulalted events with varaince and error included for personality and situational factors.

Table I.2: *Optimization Solutions* for Moderate *Neuro* Personality Blocks

Moderate *Neuro*											
Low *Extrav*				**Moderate *Extrav***				**High *Extrav***			
peX				***pXX***				***pEX***			
	Optimization Solutions	**Mean**	**Var**		**Optimization Solutions**	**Mean**	**Var**		**Optimization Solutions**	**Mean**	**Var**
Primary	Set EnvStim to low (</=-1.0) -0.2 slope//slope inversion	1.013	0.204	Primary	Set EnvStim to low (</=-1.0) -1.2 slope	1.945	0.333	Primary	Set EnvStim to low (</=-1.0) -2.3 slope	2.902	0.677
	Set ProStruc to high (>/=1.0) -0.1 slope				Set ProStruc to high (>/=1.0) -0.1 slope				Set ProStruc to high (>/=1.0) -0.3 slope		
	Set SptGrp to low (</=-1.0) -0.2 slope//slope inversion				Set SptGrp to low (</=-1.0) -0.8 slope				Set SptGrp to low (</=-1.0) -0.9 slope		
Alt 1	EnvStim low; ProStruc mod; SptGrp low	0.931	0.178	Alt 1	EnvStim low; ProStruc mod; SptGrp low	1.865	0.312	Alt 1	EnvStim low; ProStruc mod; SptGrp low	2.82	0.669
Alt 2	EnvStim low; ProStruc low; SptGrp low	0.844	0.161	Alt 2	EnvStim low; ProStruc low; SptGrp low	1.783	0.295	Alt 2	EnvStim low; ProStruc low; SptGrp low	2.723	0.628
XeX				***XXX***				***XEX***			
	Optimization Solutions	**Mean**	**Var**		**Optimization Solutions**	**Mean**	**Var**		**Optimization Solutions**	**Mean**	**Var**
Primary	Set EnvStim to high (>/=1.0) -1.2 slope	2.349	0.728	Primary	Set EnvStim to high (</=-1.0) -0.1 slope//slope inversion	1.286	0.456	Primary	Set EnvStim to low (</=-1.0) -0.5 slope	1.947	0.238
	Set ProStruc to low </=-1.0) -0.1 slope				Set ProStruc to low (</=-1.0) -0.1 slope				Set ProStruc to low (</=-1.0) -0.1 slope		
	Set SptGrp to low (</=-1.0) -0.6 slope				Set SptGrp to low (</=-1.0) -0.3 slope				Set SptGrp to low (</=-1.0) -0.1 slope//slope inversion		
Alt 1	EnvStim high; ProStruc mod; SptGrp low	2.302	0.664	Alt 1	EnvStim high; ProStruc mod; SptGrp low	1.225	0.405	Alt 1	EnvStim low; ProStruc mod; SptGrp low	1.881	0.257
Alt 2	EnvStim high; ProStruc high; SptGrp low	2.211	0.625	Alt 2	EnvStim high; ProStruc high; SptGrp low	1.159	0.372	Alt 2	EnvStim low; ProStruc high; SptGrp low	1.805	0.271
PeX				***PXX***				***PEX***			
	Optimization Solutions	**Mean**	**Var**		**Optimization Solutions**	**Mean**	**Var**		**Optimization Solutions**	**Mean**	**Var**
Primary	Set EnvStim to high (>/=1.0) -2.6 slope	4.246	1.509	Primary	Set EnvStim to high (>/=1.0) -0.8 slope	3.187	0.882	Primary	Set EnvStim to high (>/=1.0) -0.5 slope	2.124	0.516
	Set ProStruc to low (</=-1.0) -0.3 slope				Set ProStruc to low (</=-1.0) -0.3 slope				Set ProStruc to low (</=-1.0) -0.2 slope		
	Set SptGrp to low (</=-1.0) -1.0 slope				Set SptGrp to low (</=-1.0) -0.8 slope				Set SptGrp to low (</=-1.0) -0.9 slope		
Alt 1	EnvStim high; ProStruc mod; SptGrp low	4.037	1.529	Alt 1	EnvStim high; ProStruc mod; SptGrp low	2.983	0.841	Alt 1	EnvStim high; ProStruc mod; SptGrp low	1.911	0.476
Alt 2	EnvStim high; ProStruc high; SptGrp low	3.849	1.463	Alt 2	EnvStim high; ProStruc high; SptGrp low	2.745	0.778	Alt 2	EnvStim high; ProStruc high; SptGrp low	1.702	0.447

Personality labels include p, *X* or *P* for the low, moderate or high setting of Psych (Psychoticism), *e* , *X* or *E* for Extrav (Extraversion) and *n* , *X* and *N* for Neuro (Neuroticism).
Situational factors include EnvStim (Environmental Stimelation), ProStruc (process Structure) and SptGrp (Support Group).
Low, mod (moderate) and high settings represent the practical range of stimulaltion attributable to the specified situational factor.
Mean and variance (Var) indicated for each optimization solution are estimated from simulalted events with varaince and error included for personality and situational factors.

Table I.3: ***Optimization Solutions*** **for High** ***Neuro*** **Personality Blocks**

High *Neuro*

Low *Extrav* — *peN*

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to high (</=-1.0) -0.1 slope	0.643	0.341
	Set ProStruc to high (>/=1.0) -0.1 slope		
	Set SptGrp to low (</=-1.0) -0.2 slope		
Alt 1	EnvStim low; ProStruc high; SptGrp low	0.738	0.203
Alt 2	EnvStim low; ProStruc mod; SptGrp low	0.654	0.181

Moderate *Extrav* — *pXN*

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to low (</=-1.0) -1.1 slope	1.681	0.319
	Set ProStruc to high (>/=1.0) -0.1 slope		
	Set SptGrp to low (</=-1.0) -0.5 slope		
Alt 1	EnvStim low; ProStruc mod; SptGrp low	1.597	0.294
Alt 2	EnvStim low; ProStruc low; SptGrp low	1.514	0.269

High *Extrav* — *pEN*

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to low (</=-1.0) -2.2 slope	2.624	0.625
	Set ProStruc to high (>/=1.0) -0.1 slope		
	Set SptGrp to low (</=-1.0) -1.7 slope		
Alt 1	EnvStim low; ProStruc mod; SptGrp low	2.543	0.614
Alt 2	EnvStim low; ProStruc low; SptGrp low	2.444	0.559

XeN

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to high (>/=1.0) -1.2 slope	2.370	0.745
	Set ProStruc to low (</=-1.0) -0.1 slope		
	Set SptGrp to low (</=-1.0) -0.6 slope		
Alt 1	EnvStim high; ProStruc mod; SptGrp low	2.306	0.692
Alt 2	EnvStim high; ProStruc high; SptGrp low	2.254	0.662

XXN

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to high (>/=1.0) -0.1 slope//slope inversion	1.314	0.474
	Set ProStruc to low (</=-1.0) -0.1 slope		
	Set SptGrp to low (</=-1.0) -0.4 slope		
Alt 1	EnvStim high; ProStruc mod; SptGrp low	1.249	0.422
Alt 2	EnvStim high; ProStruc high; SptGrp low	1.176	0.375

XEN

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to low (</=-1.0) -0.8 slope	1.668	0.208
	Set ProStruc to low (</=-1.0) -0.1 slope		
	Set SptGrp to low (</=-1.0) -0.3 slope//slope inversion		
Alt 1	EnvStim low; ProStruc mod; SptGrp low	1.611	0.239
Alt 2	EnvStim low; ProStruc high; SptGrp low	1.552	0.256

PeN

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to high (>/=1.0) -2.7 slope	4.263	1.640
	Set ProStruc to low (</=-1.0) -0.2 slope		
	Set SptGrp to low (</=-1.0) -2.8 slope		
Alt 1	EnvStim high; ProStruc mod; SptGrp low	4.090	1.628
Alt 2	EnvStim high; ProStruc high; SptGrp low	3.849	1.531

PXN

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to high (>/=1.0) -1.7 slope	3.205	0.9400
	Set ProStruc to low (</=-1.0) -0.2 slope		
	Set SptGrp to low (</=-1.0) -1.9 slope		
Alt 1	EnvStim high; ProStruc mod; SptGrp low	2.994	0.907
Alt 2	EnvStim high; ProStruc high; SptGrp low	2.786	0.846

PEN

	Optimization Solutions	Mean	Var
Primary	Set EnvStim to high (>/=1.0) -1.1 slope//slope inversion	2.134	0.540
	Set ProStruc to low (</=-1.0) -0.3 slope		
	Set SptGrp to low (</=-1.0) -1.0 slope		
Alt 1	EnvStim high; ProStruc mod; SptGrp low	1.913	0.492
Alt 2	EnvStim high; ProStruc high; SptGrp low	1.730	0.452

Personality labels include p, *X* or *P* for the low, moderate or high setting of Psych (Psychoticism), *e* , *X* or *E* for Extrav (Extraversion) and *n* , *X* and *N* for Neuro (Neuroticism).
Situational factors include EnvStim (Environmental Stimelation), ProStruc (process Structure) and SptGrp (Support Group).
Low, mod (moderate) and high settings represent the practical range of stimulaltion attributable to the specified situational factor.
Mean and variance (Var) indicated for each optimization solution are estimated from simulalted events with varaince and error included for personality and situational factors.

APPENDIX J: EVALUATION OF THE *SYSTEM OF SITUATIONAL CONTROL*

Table J.1depicts the results of evaluation of the *system of situational control* and the comparison of these data by personality combination block against the non-optimized (control) response surface results.

Table J.1: Control vs Optimized Block Statistics

Stochastic Response Surface (Control vs Optimized Block Statisics)								
Personality Block	*Control mean(DxQual)*	*Optimized mean(DxQual)*	*Control var(DxQual)*	*Optimized var(DxQual)*	*Control max(DxQual)*	*Optimized max(DxQual)*	*Control min(DxQual)*	*Optimized min(DxQual)*
pen	0.706	0.445	0.180	0.451	3.224	2.924	-2.107	-2.225
pXn	0.898	2.215	0.700	0.382	4.952	5.072	-4.039	1.012
pEn	1.091	3.155	1.969	0.741	6.564	6.535	-6.193	1.521
peX	0.585	1.009	0.142	0.201	3.158	2.896	-2.044	-0.552
pXX	0.777	1.957	0.574	0.348	4.585	4.532	-3.926	0.830
pEX	0.971	2.882	1.762	0.700	6.454	6.342	-5.903	1.263
peN	0.465	0.632	0.121	0.345	3.075	3.061	-1.971	-1.644
pXN	0.657	1.677	0.469	0.314	4.189	4.123	-3.750	0.536
pEN	0.847	2.613	1.574	0.620	6.110	5.772	-5.955	1.092
Xen	0.697	2.331	0.725	0.683	5.925	5.752	-2.938	0.708
Pen	0.689	4.242	2.739	1.484	9.373	8.919	-4.646	1.804
PEn	1.073	2.094	0.394	0.505	5.076	5.113	-2.171	0.231
PXn	0.882	3.162	1.189	0.853	7.115	7.556	-3.550	1.398
XeX	0.575	2.365	0.800	0.717	6.001	6.164	-3.072	0.770
PeX	0.566	4.270	2.928	1.570	9.466	9.056	-5.130	1.696
XXX	0.769	1.288	0.200	0.458	3.997	4.109	-1.612	-0.770
PXX	0.759	3.192	1.291	0.888	7.376	7.521	-3.499	1.320
PEX	0.953	2.106	0.411	0.518	5.203	5.454	-2.169	0.318
XeN	0.456	2.360	0.892	0.740	6.009	5.895	-3.195	0.763
PeN	0.447	4.278	3.130	1.606	9.358	9.243	-5.141	1.657
XXN	0.649	1.309	0.207	0.464	4.281	4.082	-1.801	-0.698
PXN	0.639	3.196	1.410	0.913	7.285	7.151	-3.740	1.340
PEN	0.832	2.145	0.439	0.553	5.281	5.495	-2.419	0.453
XEn	1.080	2.216	0.452	0.256	4.776	4.434	-2.871	1.202
XXn	0.889	1.271	0.215	0.457	3.983	4.034	-1.518	-1.065
XEX	0.961	1.940	0.350	0.233	4.342	4.271	-2.816	0.890

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